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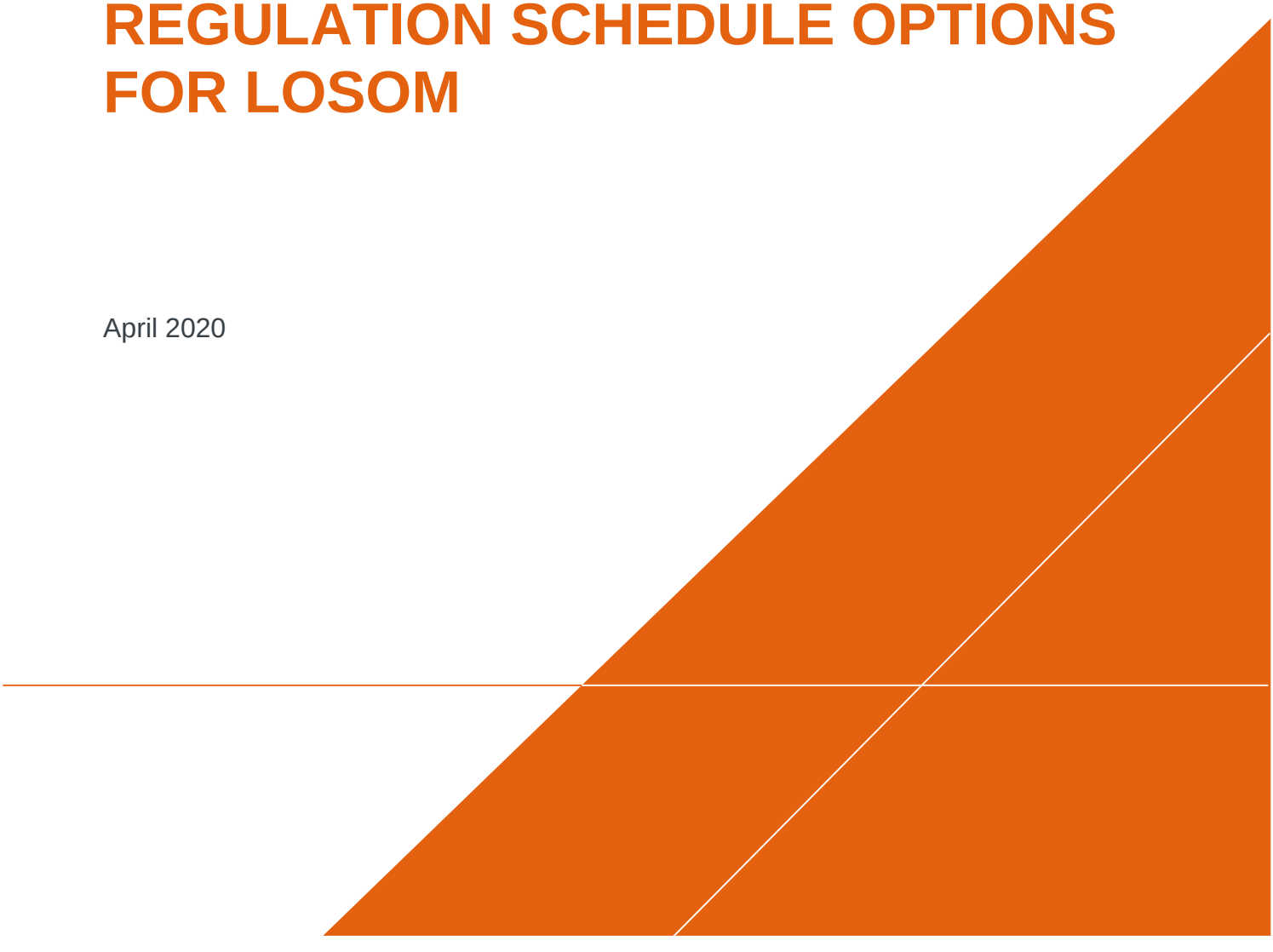
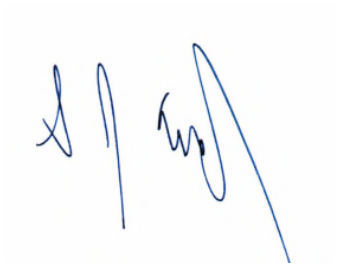
The Nature Conservancy

# SCREENING OF LAKE OKEECHOBEE REGULATION SCHEDULE OPTIONS FOR LOSOM

April 2020





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# CONTENTS

# TABLES



# FIGURES



# APPENDICES

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AF | acre-feet |
| Arcadis | Arcadis U.S., Inc. |
| ASR | aquifer storage and recovery |
| C&SF | Central and Southern Florida |
| CEPP | Central Everglades Planning Project |
| CERP | Comprehensive Everglades Restoration Plan |
| cfs | cubic feet per second |
| DIW | deep injection well |
| DMSTA | Dynamic Model for Stormwater Treatment Areas |
| EAA | Everglades Agricultural Area |
| ENV | environmental |
| FEB | flow equalization basin |
| HAB | Harmful Algal Bloom |
| IDS | Integrated Delivery Schedule |
| IORBL | Initial Operating Regime Baseline |
| IRL-S | Indian River Lagoon-South |
| kaf | thousand acre-feet |
| LOOPS | Lake Okeechobee Operations Screening |
| LORS | Lake Okeechobee Regulation Schedule |
| LORS 2008 | 2008 Lake Okeechobee Regulation Schedule |
| LOSA | Lake Okeechobee Service Area |
| LOSOM | Lake Okeechobee System Operating Manual |
| LOW | Lake Okeechobee Watershed |
| LOWSM | Lake Okeechobee Water Shortage Management |
| NEPA | National Environmental Policy Act |
| NGVD | National Geodetic Vertical Datum |
| NRC | National Research Council |
| NSM | Natural System Model |
| NSRSM | Natural System Regional Simulation Model |

| | |
|---|---|
| PACR | Post Authorization Change Report |
| PIR | Project Implementation Report |
| RECOVER | Restoration Coordination and Verification |
| RESOPS | Reservoir Sizing and Operations Screening |
| ROG | River of Grass |
| RSM | Regional Simulation Model |
| RSM-BN | Regional Simulation Model - Basins |
| RSM-GL | Regional Simulation Model – Glades and Lower East Coast Service Area |
| SFWMD | South Florida Water Management District |
| SLE | St. Lucie Estuary |
| STA | Stormwater Treatment Area |
| TNC | The Nature Conservancy |
| UF | University of Florida |
| USACE | U.S. Army Corps of Engineers |
| WCA | Water Conservation Area |
| WRDA | Water Resources Development Act |
| WSE | Water Supply and Environment |
| yr | year |

# 1 INTRODUCTION

After major flooding in South Florida in 1947, Congress authorized the Central and Southern Florida (C&SF) Project in 1948. The C&SF Project was constructed by the U.S. Army Corps of Engineers (USACE) and the South Florida Water Management District (SFWMD). The C&SF Project covers all or parts of 16 counties, extending from south of Orlando to the Florida Keys. As part of the C&SF Project, the 103-mile-long Kissimmee River was channelized into a 56-mile-long canal. Lake Okeechobee was completely encircled and contained by the Herbert Hoover Dike with outflows from the lake managed through a regulation schedule. The Caloosahatchee and St. Lucie estuaries were connected to Lake Okeechobee by the C-43 and C-44 canals, respectively. The 700,000-acre Everglades Agricultural Area (EAA) was created south of Lake Okeechobee. The east coast protective levee separated the remaining Everglades from urban and agricultural development to the east. The remaining Everglades north of Everglades National Park were divided into three large Water Conservation Areas (WCAs). Canals were constructed to move water through the system, and ultimately out to the estuaries and the ocean. USACE constructed the C&SF Project between the 1950s and the mid-1970s in cooperation with SFWMD. The C&SF Project was implemented to serve multiple purposes, including providing flood control, providing a regional water supply for agricultural and urban areas, preventing saltwater intrusion, providing a water supply to Everglades National Park, preserving fish and wildlife, and providing opportunities for recreation and navigation.

Restoration of the Everglades ecosystem is one of the largest efforts of its kind in the world. The foundation of the Everglades ecosystem restoration effort is the restoration of hydrologic conditions – “getting the water right.” To achieve this objective, USACE and SFWMD developed the Comprehensive Everglades Restoration Plan (CERP) in 1999 (USACE, 1999a). Storage is major aspect of Everglades restoration – CERP includes surface, in-ground, and underground storage to provide flows to the Everglades as well as to alleviate salinity problems in the St. Lucie and Caloosahatchee estuaries due to too much or too little freshwater flows and too high or too low levels in Lake Okeechobee. Of these storage options, Lake Okeechobee plays a critical role in water storage for Everglades restoration. CERP was formulated using the regulation schedule for Lake Okeechobee, known as Run 25, that was in effect at that time. In 2000, USACE adopted a new regulation schedule that was called the Water Supply and Environment (WSE) regulation schedule. In 2008, USACE replaced the WSE regulation schedule with a new regulation schedule known as the Lake Okeechobee Regulation Schedule (LORS). The LORS 2008 regulation schedule was adopted due to concerns about the safety and stability of the Herbert Hoover Dike that encircles Lake Okeechobee. The LORS 2008 regulation schedule reduced the amount of storage that was available in Lake Okeechobee under the WSE schedule. More recently, the excessive discharges of Lake Okeechobee water and the devastating algal blooms that occurred in 2016 and 2018 have focused public concerns on the Lake’s role in storing water to ameliorate environmental harm to the northern estuaries.

Given the changes to the system since 2008 and public pressure to reduce damaging discharges to the Caloosahatchee and St. Lucie estuaries, USACE has undertaken a process to create a new regulation schedule for the Lake. The Lake Okeechobee System Operating Manual (LOSOM) is being developed through a National Environmental Policy Act (NEPA) process and the direction provided by Section 1106 of the Water Resources Development Act (WRDA) of 2018. The purpose of LOSOM is to reevaluate and

define operations for the Lake Okeechobee Regulation Schedule taking into consideration the following new infrastructure: Herbert Hoover Dike repairs and culvert replacement (complete 2022), Kissimmee River Headwaters Revitalization (complete 2021), CERP C-43 West Basin Storage Reservoir (complete 2023), and the C-44 Reservoir and Stormwater Treatment Area (STA) (complete 2021).

The Nature Conservancy (TNC) recognizes the pivotal role that Lake Okeechobee operations play in Everglades restoration activities within the study area. TNC also recognizes that the Lake has multiple congressionally authorized purposes, including flood risk management, water supply, navigation, enhancement of fish and wildlife, and recreation. With these considerations in mind, TNC wants to support the LOSOM process by conducting an initial screening analysis of regulation schedule options and presenting the results of our analyses to the agencies, stakeholders, and public involved in LOSOM.

# 2 PROJECT SCOPE

The Nature Conservancy (TNC) has retained Arcadis U.S., Inc. (Arcadis) to provide technical assistance to TNC on LOSOM throughout the LOSOM process. Arcadis was tasked to conduct a screening analysis of Lake Okeechobee regulation schedule options and to provide information that can be used to inform the LOSOM process. It should be noted that this analysis is not a detailed analysis or evaluation of potential Lake Okeechobee regulation schedules but is presented as information that illustrates trends that can be used to inform the LOSOM process.

# 3 EVERGLADES RESTORATION AND RELATED PROJECT ACTIVITIES

This section describes the major Everglades restoration activities and related projects that will affect the development of LOSOM.

## 3.1 Herbert Hoover Dike Rehabilitation Program

The Herbert Hoover Dike is a 143-mile embankment around Lake Okeechobee. Some areas around the lake were diked early in the twentieth century. Following devastating flooding and loss of life in areas around the lake from hurricanes in 1926 and 1928, construction of the Herbert Hoover Dike was authorized in 1930 and included diking on the northern and southern portions of Lake Okeechobee. The C&SF Project incorporated and enlarged these previous efforts into the present Herbert Hoover Dike; however, the present dike is built on earlier dike construction that used hydraulic dredge and fill methods that do not meet today's construction standards. In addition, the Herbert Hoover Dike does not have any emergency overflow capability, and inflow capacity greatly exceeds outflow capacity. Since 2007, USACE has been rehabilitating the Herbert Hoover Dike to bring it into compliance with current engineering standards to reduce the risk of failure. The rehabilitation program is scheduled to be completed in 2022 and includes construction of 56 miles of cutoff wall and replacement or removal of 32 culverts.

## 3.2 Kissimmee River Restoration Project

As part of the C&SF Project, the 103-mile-long Kissimmee River was channelized into a 56-mile-long canal causing tremendous adverse effects to the ecosystem. The Kissimmee River Restoration Project was authorized by Congress in 1992 and includes backfilling 22 miles of canal and constructing new river channels to reconnect river remnants in the lower Kissimmee basin and headwaters revitalization in the upper basin. After extensive planning, construction of the restoration project began in 1999. When the restoration project is completed in 2021, more than 40 square miles of river-floodplain ecosystem will be restored, including almost 20,000 acres of wetlands and 44 miles of historic river channel. Storage in the Kissimmee River basin will be increased with the restoration of the river and wetlands.

## 3.3 Comprehensive Everglades Restoration Plan

As discussed previously, USACE and SFWMD developed CERP to provide extensive structural and operational modifications for the C&SF Project (USACE, 1999a). CERP includes more than 60 major components, such as the provision of above-ground and in-ground reservoirs; aquifer storage and recovery (ASR) wells; STAs; seepage management features; and the removal of levees and canals in natural areas to restore connectivity within the Everglades ecosystem. These components will significantly increase storage and water supply for the natural system as well as for urban and agricultural needs and provide relief to the Caloosahatchee and St. Lucie estuaries while maintaining the existing purposes of the C&SF Project. Implementation of CERP is expected to take more than 30 years.

The Caloosahatchee Estuary on the west coast and the St, Lucie Estuary on the east coast are connected to Lake Okeechobee through the C-43 and C-44 canals, respectively. When water levels in Lake Okeechobee are too high, discharges are made to the C-43 and C-44 canals that severely affect the ecology of the Caloosahatchee and St. Lucie estuaries. Two CERP projects to provide storage and mitigate the effects of water releases from Lake Okeechobee to the estuaries are currently under construction. The C-43 West Basin Storage Reservoir is scheduled to be completed in 2023 and will provide 170,000 acre-feet (AF) of storage in the Caloosahatchee Basin. The C-44 Reservoir and STA, a part of the Indian River Lagoon South project, is scheduled to be completed in 2021 and will provide 60,000 AF of storage in the St. Lucie Basin.

## 3.4 Central Everglades Planning Project

In 2014, USACE and SFWMD completed a Project Implementation Report (PIR) for the Central Everglades Planning Project (CEPP) to improve the quantity, quality, timing, and distribution of flows to the Central Everglades as well as to the Caloosahatchee and St. Lucie estuaries and Florida Bay while increasing water supply (USACE, 2014). CEPP was authorized in the WRDA of 2016 and includes a flow equalization basin (FEB) in the EAA (called A-2 FEB), operational changes to the Lake Okeechobee regulation schedule, distribution and conveyance features, and seepage management features. The A-2 FEB would be operationally integrated with the existing 60,000 AF A-1 FEB.

In March 2018, SFWMD completed a Post Authorization Change Report (PACR) to modify the A-2 FEB into a larger storage reservoir and STA (SFWMD, 2018). The revised project recommended in the PACR was authorized in WRDA 2018. The A-2 reservoir will store 240,000 AF of water and is currently

scheduled to be completed in 2028. The associated A-2 STA will be 6,500 acres and is scheduled to be completed in 2023.

## 3.5 Lake Okeechobee Operations

Encompassing more than 700 square miles, Lake Okeechobee is the largest freshwater lake in the southeastern United States. With the construction of the Herbert Hoover Dike and the adoption of a regulation schedule, Lake Okeechobee has been extensively altered from its natural state. In the years since the Herbert Hoover Dike was constructed, many regulation schedules have been adopted. These regulation schedules attempt to balance the often-conflicting goals of flood control, agricultural and urban water supply, water for the Everglades, and the ecological health of the lake itself.

At the time CERP was formulated, the lake was operated under a regulation schedule known as Run 25 (USACE, 1999a). Since the development of CERP in 1999, the regulation schedule has been modified twice. In 2000, USACE implemented a revised schedule called Water Supply and Environment (WSE). The WSE schedule was developed to reduce adverse impacts to the lake's littoral zone and the estuaries while still meeting water supply demands (NRC, 2016). The WSE regulation schedule (USACE, 1999b) also incorporated a "decision tree" into lake operations that allowed water managers to consider anticipated short- and long-term conditions in making decisions.

In 2008, USACE implemented a new lower regulation schedule for Lake Okeechobee, called LORS 2008, due to the concerns regarding the safety of Herbert Hoover Dike (USACE, 2007). Under this lower regulation schedule, there is less water storage available in Lake Okeechobee and an increased frequency of releases to the Caloosahatchee and St. Lucie estuaries. Section 1106 of WRDA 2018 directed USACE to expedite completion of the Lake Okeechobee regulation schedule to coincide with the completion of the Herbert Hoover Dike Rehabilitation project.

Due to its large size, Lake Okeechobee provides the largest water storage area in the Everglades ecosystem. According to NRC (2016), the LORS 2008 schedule provides for a storage area that is 1.25 feet lower than the Run 25 and WSE schedules, which is equivalent to a loss of 564,000 AF of potential storage capacity. Under the LORS 2008 schedule, when water levels are in the lower operational bands and the water shortage zone, SFWMD makes recommendations to USACE about water releases based on Adaptive Protocols procedures that were adopted by SFWMD in 2010. The Adaptive Protocols include strategies to keep the lake lower by releasing a low volume of water to the estuaries year-round to reduce the risk of high-volume estuary releases.

# 4 SCREENING ANALYSIS OF STORAGE OPTIONS

## 4.1 Approach

In recognition of the need to quickly analyze preliminary regulation schedule options, the project team determined that screening models were needed that could be used to assist in the analysis. The project team also determined that performance measures appropriate to understanding Lake Okeechobee regulation schedule effects on the Caloosahatchee and St. Lucie estuaries, Lake Okeechobee, the Everglades, and water supply were also needed. Base conditions using both the current LORS 2008

(Existing Conditions) and the previous WSE regulation schedule were developed and modeled to provide comparison points for the regulation schedule options. Various Lake Okeechobee regulation schedule options were then modeled with the screening tool and the modeled performance outputs for key performance measures were analyzed.

## 4.2 LOOPS Screening Model

The Lake Okeechobee Operations Screening (LOOPS) model is a hydrologic simulation tool developed by SFWMD that provides screening level testing of operating rules for Lake Okeechobee, including regulation schedules, water shortage plans, and protocols for defining release amounts when the regulation schedule guidance only provides a range of possible flow rates (Neidrauer, et al., 2006). Analysts can use LOOPS to easily test a broad variety of operating strategies and receive instant feedback showing the performance for the primary lake-management objectives. LOOPS is not intended to replace more comprehensive regional-scale modeling; rather, it is a screening tool that can help design schedules for further, more in-depth, analysis. LOOPS is based on similar algorithms as the regional-scale models, but its domain is limited to Lake Okeechobee and its tributaries.

LOOPS is a hydrologic routing model that performs a 41-year continuous (daily time-steps) hydrologic simulation in a Microsoft Excel spreadsheet that utilizes cell-based data input organized to support a complex series of interrelated calculations, known as “macros”, within an extensive series of workbook tabs. LOOPS simulates Lake Okeechobee stages and discharges through the primary outlets as prescribed by a user-defined regulation schedule. Inputs include daily time-series values for the Lake net inflow, basin runoff from the Caloosahatchee and St. Lucie basins, lake evaporation rates, and the hydrologic state and forecast information that drive regulation schedules like LORS 2008. LOOPS can be set up to use either historical or regional model-simulated input data. The basic structure of LOOPS is illustrated in Figure 1. For this analysis of options for LOSOM, LOOPS version 6.32 was used to develop the regulation schedule for one of the runs described in *Section 4.8 RESOPS Simulations*.

## 4.3 RESOPS Screening Model

After reviewing potential hydrologic models that could be used for this project, the project team selected the **RE**servoir Sizing and **OP**erations **S**creening (RESOPS) Model developed by SFWMD (SFWMD, 2009) as the appropriate tool for the regulation schedule screening analysis. The RESOPS model is a spreadsheet-based tool that utilizes cell-based data input organized to support a complex series of interrelated calculations, known as “macros”, within an extensive series of workbook tabs. The most utilized of the worksheets is associated with the operational routing of the primary hydrologic features (e.g., Lake Okeechobee, reservoirs, ASR, and deep injection wells (DIW)). Key to defining these routing rules is a series of operational “switches” that pertain to alternative operational modes for various key components. For example, these switches define; the degree of Kissimmee River Restoration imposed by a given run, the interrelationship of external storage reservoirs to both Lake Okeechobee and the downstream estuaries, water supply demands, and Everglades flow targets. Each alternative has a relatively unique set of “switches” depending on the underlying base condition proposed for the run.

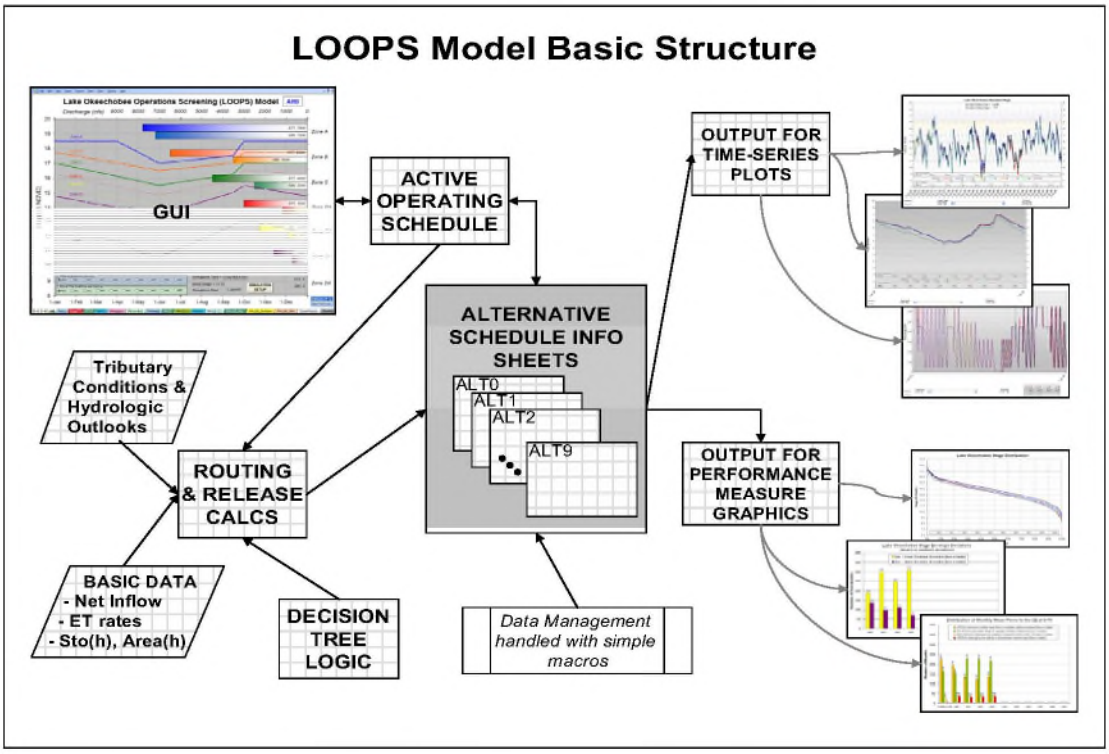


**Figure 1. Basic Structure of the LOOPS Model (from Neidrauer, et. al., 2006)**

RESOPS provides rapid screening-level testing of the integrated effects of alternative reservoir sizes and treatment areas and proposed operating rules for: Lake Okeechobee, the Northern Everglades Storage (including ASR and DIW), EAA Storage, C-43 Storage, C-44 Storage, Flows to the Everglades, and Lake Okeechobee Service Area (LOSA) water supply.

Figure 2 is a schematic of these areas and their linkages in the RESOPS model. The schematic shows the four major reservoirs and the treatment area that can be simulated in RESOPS. The model performs a 41-year continuous simulation (monthly time-steps) of the hydrology and operations of the water management system. The model's strength is its ability to quickly test the performance of alternative water storage features. RESOPS is a spreadsheet-type model that runs in Microsoft Excel. The user sets various switches on several spreadsheets to set input values and reservoir and treatment area sizes.

Input requirements for the model include:

- Reservoir and treatment area capacities and operations
- Lake Okeechobee operations (i.e., regulation schedule)
- Monthly time series (1965 through 2005) of rainfall, evaporation, tributary basin runoff, service area demands, and estuary water needs
- Everglades water needs (Everglades Demand Time Series)

RESOPS can simulate flows to the Everglades by attempting to meet a flow target time-series at the northern boundary of WCA-3A. The flow target time series was developed by SFWMD utilizing the Natural System Regional Simulation Model (NSRSM) to create a boundary condition for flows that were deemed beneficial for the Everglades landscape. RESOPS cannot simulate the hydrologic or ecological consequences of sending more water to the Everglades. Evaluation of the impacts to the Everglades hydropatterns from additional flows requires more detailed models and analysis.

RESOPS is a screening level tool that is useful for quickly analyzing different configurations of treatment areas, storage reservoirs, and Lake Okeechobee regulation schedules. While a useful tool, RESOPS is not a replacement for more detailed analysis using the capabilities of regional scale models such as the Regional Simulation Model- Basins (RSM-BN) and the Regional Simulation Model – Glades and Lower East Coast Service Area (RSM-GL).

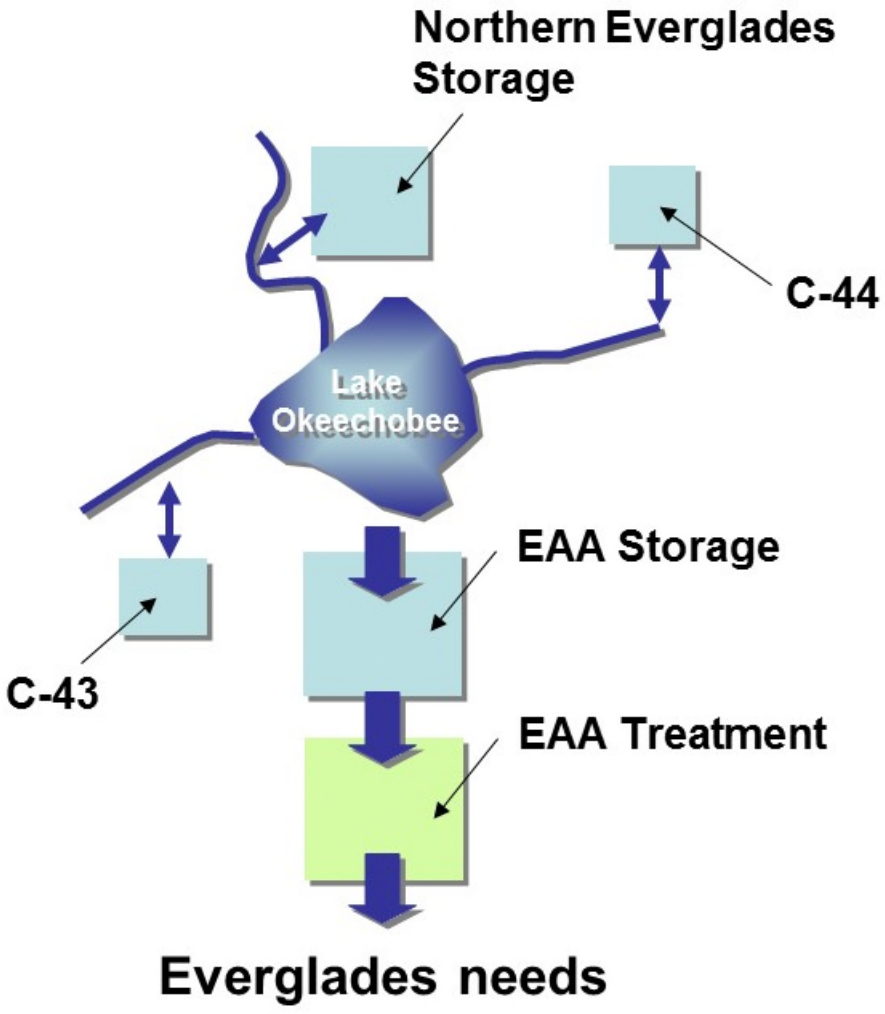


**Figure 2. RESOPS System Schematic (from SFWMD, 2009)**

The RESOPS model includes many hydrological outputs including water budgets, stage hydrographs, and stage and flow duration curves for Lake Okeechobee and the reservoirs; Lake stage envelope scores; estuary flow distributions; water deliveries to the Everglades; and water shortage indicators. SFWMD has used the RESOPS model to conduct screening-level analyses for several planning efforts, the River of Grass (ROG) planning process, and most recently for the Lake Okeechobee Watershed (LOW) Restoration Project PIR. RESOPS version 3.9, which is SFWMD's latest version of the model, was used in conducting the analysis presented in this report and was also the version of the model used by USACE and SFWMD to perform screening analysis for the LOW Restoration Project PIR.

## 4.4 Limitations of RESOPS

While RESOPS is appropriate for screening-level analyses, it is important to understand the limitations inherent with using this model. These limitations include:

- RESOPS can only model reservoirs north of Lake Okeechobee, east of the lake on the C-44 Canal, west of the lake on the C-43 Canal, and in the EAA. Consequently, RESOPS cannot be used to model reservoirs in other areas or reservoirs that would capture local basin-generated runoff in the St. Lucie local basins (e.g., C-23, C-24, or C-25 canals).
- RESOPS can only model ASR and DIW features north of Lake Okeechobee. Consequently, ASR or DIW cannot be evaluated in other areas with RESOPS. In addition, RESOPS does not evaluate ASR and DIW features that are directly connected to specific storage reservoirs north of Lake Okeechobee, but instead evaluates ASR and DIW as water directly injected from/to the Lake.
- RESOPS cannot simulate the hydrologic or ecological consequences of sending more water to the Everglades and does not analyze the effects of alternatives on Everglades habitat. More detailed models and tools such as the RSM-GL model need to be used for that purpose.
- RESOPS only allows the inclusion of water quality treatment areas (i.e., STAs) coupled with a reservoir in the EAA south of Lake Okeechobee; RESOPS does not allow STAs to be placed in other areas.
- RESOPS accounts for the inclusion of a treatment area in the EAA from a water budget standpoint but does not analyze treatment area effects on water quality.
- RESOPS is useful for a comparative analysis of alternative regulation schedules but should not be used to determine absolute effects or benefits of an alternative. More detailed models should be used for that type of analysis (i.e., analysis and selection of a recommended regulation schedule).

## 4.5 Performance Measures

RESOPS includes many performance outputs as described previously. For this analysis, performance outputs from the RESOPS model that show the effects of regulation schedule options on Lake Okeechobee stages, high flows from Lake Okeechobee to the Caloosahatchee and St. Lucie estuaries, water deliveries to the Everglades, and water supply to LOSA were selected. Some of the RESOPS performance outputs are also linked to CERP performance measures that have been developed by the

Restoration Coordination and Verification (RECOVER) team. The performance measures selected for this analysis are described below.

**Lake Okeechobee Stages:** RECOVER has developed performance measures to evaluate the benefits of seasonally variable water levels in Lake Okeechobee on the plant and animal communities of the lake and on the adverse impacts of extreme high and low water levels on the littoral and near-shore areas of Lake Okeechobee (RECOVER, 2007a). For the seasonably variable water levels in the lake, the RECOVER performance measure is based on a lake stage envelope that ranges from elevation 12 feet NGVD to 16 feet NGVD, depending on the time of year. RESOPS calculates the amount of time (number of weeks) that the lake is above or below the target envelope and then standardizes the score over the period of record so that performance is measured on a scale of 0-100%. Stage envelope standard scores (standard score above stage envelope and standard score below stage envelope) measure the departure of the lake stage from the envelope. A higher score means fewer departures and better in-Lake habitat and ecology. For deviation of lake stage above the envelope, that target is 0 (zero) feet-weeks. For deviation of lake stage above the envelope, the target is 192 feet-weeks. RECOVER also developed a performance measure for extremes in high and low lake stages. For extremes in high (>17 feet) and low (<10 feet) lake stages, the target is 0 (zero) weeks. While performance measures for the percentage of time the lake exceeded extreme high or low stages are important, the stage envelope performance measure was chosen as best for measuring how storage options perform relative to keeping the lake within the stage target range. It should be noted that RECOVER just adopted a revised lake stage envelope performance measure; however, RESOPS uses the current 2007 lake stage envelope performance measure.

**Caloosahatchee Estuary:** RECOVER (2007b) developed a salinity range favorable to marine life and submerged aquatic vegetation for the Caloosahatchee estuary. For high-flow conditions, the performance target is no months with mean monthly flows greater than 2,800 cubic feet per second (cfs), as measured at S-77 from Lake Okeechobee regulatory releases in combination with flows from the Caloosahatchee River (C-43) basin. Since this project is focused on understanding how storage and Lake Okeechobee regulation schedule options affect system performance, the project team considered only the high-flow months that were due to Lake Okeechobee regulatory releases. Caloosahatchee basin runoff is a separate component of the performance measure and was not considered in this analysis. For low-flow conditions, the target is no months during October to July when the mean monthly inflow from the Caloosahatchee watershed, as measured at S-79, falls below a low-flow limit of 450 cfs (C-43 basin runoff and Lake Okeechobee regulatory releases). Lower scores mean less months where flows are above or below the targets RECOVER is currently developing a new salinity range performance measure for the Caloosahatchee estuary; however, RESOPS still uses the 2007 Caloosahatchee Estuary performance measure.

**St. Lucie Estuary:** RECOVER (2007b) developed a salinity range favorable to marine life and submerged aquatic vegetation for the St. Lucie estuary. For high-flow conditions, the target is no months with mean monthly flows greater than 2,000 cfs, as measured at S-308 from Lake Okeechobee regulatory releases in combination with flows from the C-23 and C-24 basins. Since this project is focused on understanding how storage and Lake Okeechobee regulation schedule options affect system performance, the project team considered only the high-flow months that were due to Lake Okeechobee regulatory releases. St. Lucie basin runoff is a separate component of the performance measure and was not considered in this analysis. For low-flow conditions, the target is 31 months over the 41-year period of

record where the mean monthly inflow from the St. Lucie watershed, as measured in the St. Lucie Estuary, falls below a low-flow limit of 350 cfs (local basin runoff and Lake Okeechobee regulatory releases). Lower scores mean less months where flows are above or below the targets. RECOVER is currently developing a new salinity range performance measure for the St. Lucie estuary; however, RESOPS still uses the 2007 St. Lucie Estuary performance measure.

**Everglades Water Deliveries:** The NSRSM model provides estimates of pre-drainage flows to the Everglades, which varied throughout the year. Detailed hydrologic models such as RSM-GL are used to simulate flow quantities and patterns in the remaining Everglades. Due to high uncertainties in the Everglades water needs and complexities associated with modeling simulations of the Everglades, the Everglades water needs (targets) are simulated by the RESOPS model as a user-defined flow time-series. Consequently, RESOPS cannot estimate specific benefits or impacts to the Everglades hydropatterns from additional flows. Instead, RESOPS computes average annual Everglades water deliveries (in kaf/year) toward environmental targets as well as Everglades deliveries that are in excess of environmental targets. For this project, the project team considered the total flows (both toward environmental targets and those in excess of environmental targets) delivered to the Everglades.

**LOSA Water Supply:** Lake Okeechobee is the primary source of supplemental irrigation for four major adjacent agricultural basins: North Shore, Caloosahatchee, St. Lucie, and EAA. Collectively, these basins are referred to as the Lake Okeechobee Service Area or LOSA. During the dry season when precipitation is low, local sources of irrigation become scarce and the need for supplemental irrigation becomes necessary. With the current absence of substantial off-site storage, Lake Okeechobee is presently the only source of supplemental irrigation for these basins. Average annual supplemental irrigation requirement from Lake Okeechobee amounts to about half a million AF. When the Lake stage falls below the Water Shortage Trigger Line, water supplies to LOSA are cutback according to SFWMD's Lake Okeechobee Water Shortage Management (LOWSM) Plan (SFWMD, 2007). The further the stage falls below the Water Shortage Trigger Line, the larger the cutback. RESOPS calculates the mean annual volume of cutbacks in LOSA over the 41-year simulation period.

## 4.6 Base Conditions

Base conditions represent a starting point for understanding system performance, either under current conditions or with some defined set of conditions and projects in place. Regulation schedule options can be compared to base conditions to understand how a given option performs when compared to base conditions.

### 4.6.1 Existing Conditions Bases

For this project, the project team developed two existing conditions bases – the Existing Conditions Base and the Existing Conditions with WSE Base. Each of these base conditions is described in the following paragraphs and specific input and switch settings for the RESOPS model for each of these existing base conditions are summarized in Table 1.

**Table 1. RESOPS Switch Settings for Existing Conditions Bases**

| Input | Existing Conditions Base | Existing Conditions with WSE Base |
|---|---|---|
| Kissimmee Operations | Option 4 (RSMBN Simulation of 2012 Existing Conditions) | Option 4 (RSMBN Simulation of 2012 Existing Conditions) |
| Lake Okeechobee | LORS 2008 Regulation Schedule | WSE Regulation Schedule |
| ASR | 0 AF/month | 0 AF/month |
| DIW | 0 | 0 |
| North (Northern Everglades) Storage | 0 AF | 0 AF |
| East (C-44) Storage | 0 AF | 0 AF |
| West (C-43) Storage | 0 AF | 0 AF |
| South (EAA) Storage | 60,000 AF (A-1 FEB) | 60,000 AF (A-1 FEB) |
| EAA Treatment Areas | 65,546 acres | 65,546 acres |
| Everglades Demand Times Series | Option 6 – DMSTA (A-1 FEB) | Option 6 – DMSTA (A-1 FEB) |

The Existing Conditions Base represents conditions as they exist today. This condition includes only completed projects that are fully operational and the current operations of the system with those projects in place. Specifically, the Existing Conditions Base includes a 60,000 AF south reservoir (A-1 FEB) in the EAA and 65,546 acres of STAs in the EAA. The total STA acreage is based on the following assumptions included in the draft RSM-BN 2020 Existing Conditions Baseline for LOSOM that have been developed by USACE:

- STA-1E: 6,546 acres total area
- STA-1W: 7,488 acres total area
- STA-2: cells 1,2 & 3: 7,681 acres total area
- STA-2N: cells 4,5 & 6; refers to Comp B-North: 6,531 acres total area
- STA-2S: cells 7 & 8; refers to Comp B-South: 3,570 acres total area
- STA-3/4: 17,126 acres total area
- STA-5N: includes cells 1 & 2: 5,081 acres total area
- STA-5S: includes cells 3, 4 & 5; uses footprint of Compartment C: 8,469 acres total area
- STA-6: expanded with phase 2: 3,054 acres total area

The Existing Conditions Base also includes current Kissimmee River operations (i.e. pre-restoration project conditions) and the LORS 2008 regulation schedule for Lake Okeechobee. The Everglades Demand Time Series (DMSTA (A-1 FEB)) is an Everglades time-series based on the treatment capacity of the STAs and the ability of the existing system to move water through the Everglades with the A-1 FEB in place.

The Existing Conditions with WSE Base uses the same assumptions as the Existing Conditions Base except for using the WSE regulation schedule for Lake Okeechobee instead.

### 4.6.2 Future Conditions Bases

Future conditions represent changes to the base conditions that are expected to occur in the south Florida ecosystem as a result of implementation of CERP projects as well as other activities that will be completed by the end of 2023. USACE has developed an Integrated Delivery Schedule (IDS) that depicts the schedule for and relationships among all federally funded South Florida ecosystem projects as well as relevant state-funded projects. The most recent version of the IDS was released in October 2019 and includes project schedules through 2030 (USACE, 2019). The IDS is used to guide sequencing for planning, design, and construction activities and to estimate funding levels needed to support project schedules. CERP projects are included in the IDS as well as associated non-CERP projects such as the Kissimmee River Restoration Project, the Herbert Hoover Dike rehabilitation program, and SFWMD's Restoration Strategies program.

For this project, the project team developed two future conditions bases – the Future Conditions Base and the Future Conditions with WSE Base. Each of these base conditions is described in the following paragraphs and specific input and switch settings for the RESOPS model for each of these future conditions base conditions are summarized in Table 2.

The Kissimmee River restoration project will be completed in 2021 and the Future Conditions Base assumes that the initial operating regime for the completed Kissimmee River Restoration Project will be utilized. The Future Conditions base assumes that the STA-1 West expansion (6,500 acres) and the A-2 STA (6,500 acres) projects are complete, which will result in 13,000 acres of additional STA area in the EAA. This brings the total area of STAs in the Future Conditions Base to 78,546 acres in the EAA.

In addition to the 60,000 AF A-1 FEB, the Future Conditions Base also includes a 170,000 AF west reservoir (C-43) and a 60,000 AF east reservoir (C-44), and the DMSTA (A-1 FEB) Everglades Demand Time Series.

The Future Conditions with WSE Base uses the same assumptions as the Future Conditions Base except for using the WSE regulation schedule for Lake Okeechobee instead of the LORS 2008 regulation schedule.

**Table 2. RESOPS Switch Settings for Future Conditions Bases**

| Input | Future Conditions Base | Future Conditions with WSE Base |
|---|---|---|
| Kissimmee Operations | Option 5 (RSMBN Simulation of IORBL1) | Option 5 (RSMBN Simulation of IORBL1) |
| Lake Okeechobee | LORS 2008 Regulation Schedule | WSE Regulation Schedule |
| ASR | 0 AF/month | 0 AF/month |
| DIW | 0 | 0 |
| North (Northern Everglades) Storage | 0 AF | 0 AF |
| East (C-44) Storage | 60,000 AF (C-44) | 60,000 AF (C-44) |
| West (C-43) Storage | 170,000 AF (C-43) | 170,000 AF (C-43) |
| South (EAA) Storage | 60,000 AF (A-1 FEB) | 60,000 AF (A-1 FEB) |
| EAA Treatment Areas | 78,546 acres | 78,546 acres |
| Everglades Demand Times Series | Option 6 – DMSTA (A-1 FEB) | Option 6 – DMSTA (A-1 FEB) |

## 4.7 RESOPS Simulations

RESOPS simulations were made to model the base conditions as well as changes to the Lake Okeechobee regulation schedule and the addition of the A-2 reservoir. The *Base Conditions Runs* include the four base conditions. The *Lake Okeechobee Regulation Schedule Change Runs* include various Lake Okeechobee regulation schedule options that raise or lower the LORS 2008 or WSE regulation schedules. The *A-2 Reservoir Runs* include various Lake Okeechobee regulation schedule options that incorporate the A-2 reservoir (240,000 AF) in the EAA that is expected to be completed by 2028. Each of these RESOPS runs is described below.

**Base Conditions Runs**

- **Run 0 - Existing Conditions Base.** This run represents the Existing Conditions Base. The input switches for this run are shown in Table 1.
- **Run 1 – Existing Conditions with WSE Base.** This run represents the existing conditions, except for reverting back to the WSE regulation schedule for Lake Okeechobee that was in effect before 2008. The input switches for this run are shown in Table 1.

- **Run 2 - Future Conditions Base.** This run includes changes that are expected to occur in the C&SF Project area as a result of implementation of CERP projects as well as other activities that will be completed by the end of 2023. The input switches for this run are shown in Table 2.
- **Run 3 - Future Conditions with WSE Base.** This run includes reverting back to the WSE regulation schedule along with the future conditions input switches shown in Table 2.

**Lake Okeechobee Regulation Schedule Change Runs**

- **Run 4 - Raise LORS 2008 Schedule by 0.5 Feet.** This run includes raising the LORS 2008 regulation schedule by 0.5 feet along with the future conditions input switches shown in Table 2.
- **Run 5 - Raise LORS 2008 Schedule by 1.0 Feet.** This run includes raising the LORS 2008 regulation schedule by 1.0 feet along with the future conditions input switches shown in Table 2.
- **Run 6 - Raise WSE Schedule by 0.5 Feet.** This run includes reverting back to the WSE regulation schedule and raising that regulation schedule by 0.5 feet along with the future conditions input switches shown in Table 2.
- **Run 7 - Raise WSE Schedule by 1.0 Feet.** This run includes reverting back to the WSE regulation schedule and raising that regulation schedule by 1.0 feet along with the future conditions input switches shown in Table 2.
- **Run 8 - Lower LORS 2008 Schedule by 0.5 Feet.** This run includes lowering the LORS 2008 regulation schedule by 0.5 feet along with the future conditions input switches shown in Table 2.
- **Run 9 - Lower LORS 2008 Schedule by 1.0 Feet.** This run includes lowering the LORS 2008 regulation schedule by 1.0 feet along with the future conditions input switches shown in Table 2.
- **Run 10 - Lower WSE Regulation Schedule by 0.5 feet.** This run includes reverting back to the WSE regulation schedule and lowering that regulation schedule by 0.5 feet along with the future conditions input switches shown in Table 2.
- **Run 11 - Lower WSE Regulation Schedule by 1.0 feet.** This run includes reverting back to the WSE regulation schedule and lowering that regulation schedule by 1.0 feet along with the future conditions input switches shown in Table 2.
- **Run 12 - LORS 2008 Schedule Deviation.** This run was based on the USACE 2019 planned deviation from the LORS 2008 regulation schedule that is under consideration to reduce Harmful Algae Blooms (HABs) to the estuaries. The input regulation schedule developed for this run was based on a previously developed LOOPS model (LOOPS was previously described in *Section 4.2 LOOPS Screening Model*). The LOOPS model was used to model the USACE planned deviation by (1) increasing Base Flow releases to 2,000 and 730 cfs to the Caloosahatchee and St. Lucie respectively, (2) lowering the Beneficial Use Band to the higher of 12 ft or 0.25 ft above the Water Shortage Line, and (3) cutting off all estuary regulatory releases below the Intermediate Band in the “algae months” of June through September. For the RESOPS modeling, the schedule developed in the LOOPs model was then slightly adjusted to account for differences between the LOOPS and RESOPS models, including, but not limited to, fewer available input points for the regulation schedule and incompatible time steps between the LOOPS and RESOPS models (RESOPS monthly vs.

LOOPS daily). This adjusted regulation schedule was then included along with the future conditions input switches shown in Table 2.

**A-2 Reservoir Runs**

- **Run 13 - A-2 Reservoir.** This run includes the LORS 2008 regulation schedule, the future conditions input switches shown in Table 2, and the 240,000 AF A-2 Reservoir described in the CEPP PACR that is scheduled to be completed in 2028.
- **Run 14 - A-2 Reservoir with 1.0-foot Lower Regulation Schedule.** This run includes lowering the LORS 2008 regulation schedule by 1.0 feet, the future conditions input switches shown in Table 2, and the 240,000 AF A-2 Reservoir described in the CEPP PACR that is scheduled to be completed in 2028.
- **Run 15 - A-2 Reservoir with WSE Regulation Schedule.** This run includes reverting back to the WSE regulation schedule, the future conditions input switches shown in Table 2, and the 240,000 AF A-2 Reservoir described in the CEPP PACR that is scheduled to be completed in 2028.

# 5 MODELING RESULTS

All the runs described in the previous section were made using the RESOPS model. Summary performance results for all the RESOPS runs are presented in Table 3. The performance summary outputs from the RESOPS model runs are included in Appendix A. Performance graphs derived from the RESOPS outputs are included in Appendix B.

The RESOPS screening model focuses on the hydrologic performance of the options. More detailed analyses of the options, including more detailed modeling using the RSM-BN and RSM-GL models, need to be conducted to determine the feasibility of these options and their performance against a full suite of performance measures.

**Table 3. Summary of Simulated Performance for Base Conditions, Lake Okeechobee Regulation Schedule Change, and A-2 Reservoir Runs**

| Run Name | Estuaries | | | | Lake Okeechobee | | Lake Okeechobee Service Area | Everglades |
|---|---|---|---|---|---|---|---|---|
| | Caloosahatchee | | St. Lucie | | | | | |
| | Additional High-Flow Months from Lake Okeechobee Regulation Schedule (Months S79>2800 cfs) (Lower Number is Better) | Estimated Low-Flow (Months S79<450 cfs) (Lower Number is Better) | Additional High-Flow Months from Lake Okeechobee Regulation Schedule (Months SLE>2000 cfs) (Lower Number is Better) | Estimated Low-Flow (Months SLE<350 cfs) (Lower Number is Better) | Standard Score Above Stage Envelope (Higher Score is Better) | Standard Score Below Stage Envelope (Higher Score is Better) | Mean Annual Cutback Volume (kaf/yr) (Lower Number is Better) | Total Everglades Water Deliveries (Towards Environmental Target + In Excess of Environmental Target) (kaf/year) |
| **Base Conditions Runs** | | | | | | | | |
| Run 0 - Existing Conditions Base | 40 | 53 | 40 | 42 | 79 | 24 | 45 | 1,214 |
| Run 1 – Existing Conditions with WSE Base | 45 | 41 | 37 | 34 | 55 | 47 | 38 | 1,217 |
| Run 2 - Future Conditions Base | 41 | 19 | 41 | 34 | 78 | 35 | 33 | 1,181 |
| Run 3 - Future Conditions with WSE Base | 46 | 22 | 41 | 20 | 52 | 63 | 25 | 1,185 |
| **Lake Okeechobee Regulation Schedule Change Runs** | | | | | | | | |
| Run 4 - Raise LORS 2008 Schedule by 0.5 Feet | 56 | 25 | 47 | 41 | 79 | 28 | 35 | 1,180 |
| Run 5 - Raise LORS 2008 Schedule by 1.0 Feet | 53 | 23 | 49 | 32 | 69 | 42 | 33 | 1,182 |
| Run 6 - Raise WSE Schedule by 0.5 Feet | 42 | 19 | 38 | 17 | 34 | 71 | 22 | 1,187 |
| Run 7 - Raise WSE Schedule by 1.0 Feet | 40 | 19 | 34 | 17 | 16 | 75 | 21 | 1,187 |
| Run 8 - Lower LORS 2008 Schedule by 0.5 Feet | 61 | 15 | 55 | 52 | 92 | 0 | 49 | 1,167 |
| Run 9 - Lower LORS 2008 Schedule by 1.0 Feet | 71 | 15 | 62 | 63 | 96 | 0 | 59 | 1,149 |
| Run 10 - Lower WSE Regulation Schedule by 0.5 feet | 50 | 27 | 46 | 26 | 67 | 52 | 28 | 1,183 |
| Run 11 - Lower WSE Regulation Schedule by 1.0 feet | 52 | 31 | 48 | 33 | 79 | 43 | 31 | 1,181 |
| Run 12 – LORS 2008 Schedule Deviation | 33 | 27 | 38 | 64 | 85 | 0 | 51 | 1,168 |
| **A-2 Reservoir Runs** | | | | | | | | |
| Run 13 - A-2 Reservoir | 38 | 21 | 39 | 37 | 79 | 33 | 32 | 1,213 |
| Run 14 - A-2 Reservoir with 1.0-foot Lower Regulation Schedule | 46 | 13 | 43 | 55 | 92 | 1 | 41 | 1,171 |
| Run 15 – A-2 Reservoir with WSE Regulation Schedule | 38 | 27 | 37 | 25 | 58 | 56 | 26 | 1,239 |

# 6 OBSERVATIONS

The screening analysis conducted for this project using RESOPS is not a detailed analysis of alternative Lake Okeechobee regulation schedules, but is a useful exercise in understanding trends due to changes in the regulation schedule and additional storage south of the lake, and can provide insights that can inform the development of LOSOM. Based on the RESOPS modeling we conducted, and the performance graphs presented in Appendix B, we offer the following observations.

## 6.1 Lake Okeechobee Stage Envelope Performance

For the Base Conditions Runs (Runs 0-3), the addition of the Caloosahatchee (C-43) and St. Lucie (C-44) storage reservoirs in the Future Conditions Base improves the standard score below stage envelope performance in Lake Okeechobee while not impacting the standard score above stage envelope performance when compared to the Existing Conditions Base. Reverting to the WSE schedule worsens the standard score above stage envelope performance while the standard score below stage envelope performance improves for both existing and future conditions.

For the Lake Okeechobee Regulation Schedule Change Runs (Runs 4-12), raising of the LORS 2008 schedule by 1.0 foot improves the standard score below stage envelope performance in Lake Okeechobee, while worsening the standard score above stage envelope performance when compared to the Future Conditions Base. Raising of the WSE schedule tends to greatly improve the standard score below stage envelope performance while also greatly worsening the standard score above stage envelope performance when compared to the Future Conditions Base. Lowering of the LORS 2008 schedule tends to greatly improve the standard score above stage envelope performance while also greatly worsening the standard score below stage envelope performance when compared to the Future Conditions Base. Lowering of the WSE schedule by 0.5 foot greatly improves the standard score below stage envelope performance while worsening the standard score above stage envelope performance when compared to the Future Conditions Base. The LORS 2008 schedule deviation improves the standard score above stage envelope performance while severely worsening the standard score below stage envelope performance when compared to the Future Conditions Base.

For the A-2 Reservoir Runs (Runs 13-15), the addition of the A-2 reservoir has negligible effect on the stage envelope performance in Lake Okeechobee when compared to the Future Conditions Base. When the A-2 reservoir is also coupled with a lowering of the Lake Okeechobee regulation schedule, the standard score above stage envelope performance greatly improves while the standard score below stage envelope performance greatly worsens when compared to the Future Conditions Base. Reverting to the WSE schedule with the A-2 reservoir lowers the standard score above stage envelope performance while improving the standard score below stage envelope performance when compared to the Future Conditions Base.

The addition of regional reservoir storage (C-43 and C-44) allows the reservoirs to work together with Lake Okeechobee to address both high and low stage conditions in the Lake relative to the desired stage envelope. Raising the regulation schedule essentially relaxes the tendency to ‘push’ water out of the Lake at a given stage. Therefore, raising the schedule generally increases stages in the Lake relative to the current schedule. The A-2 reservoir provides capacity to send water to improve Everglades deliveries.

However, while the A-2 reservoir improves the ability of the Lake to operate within its desired range of stages, the system capacity restrictions appear to limit the ability to mitigate undesirable stages in the Lake.

## 6.2 Caloosahatchee Estuary Performance

For the Base Condition Runs (Runs 0-3), the addition of the Caloosahatchee (C-43) and St. Lucie (C-44) storage reservoirs in the Future Conditions Base greatly improves the low flow discharge exceedance performance in the Caloosahatchee Estuary while not changing high flow discharge exceedance performance when compared to the Existing Conditions Base. Reverting to the WSE schedule under existing conditions improves the low flow discharge exceedance performance and slightly worsens high flow discharge exceedance performance while reverting to WSE under future conditions worsens both high and low flow discharge exceedance performance when compared to the Future Conditions Base.

For the Lake Okeechobee Regulation Schedule Change Runs (Runs 4-12), raising of the LORS 2008 schedule tends to worsen both high flow discharge exceedance and low flow discharge exceedance performance in the Caloosahatchee Estuary when compared to the Future Conditions Base. Lowering of the LORS 2008 schedule improves low flow discharge exceedance performance but greatly worsens high flow discharge exceedance performance when compared to the Future Conditions Base. Raising of the WSE schedule tends to have no appreciable effect on both low flow and high flow discharge exceedance performance when compared to the Future Conditions Base. Lowering of the WSE schedule worsens both high flow discharge exceedance and low flow discharge exceedance performance when compared to the Future Conditions Base. The LORS 2008 schedule deviation improves high discharge exceedance performance while worsening low flow discharge exceedance performance when compared to the Future Conditions Base.

For the A-2 Reservoir Runs (Runs 13-15), the addition of the A-2 reservoir slightly improved high discharge exceedance performance in the Caloosahatchee Estuary while slightly worsening low flow discharge exceedance performance when compared to the Future Conditions Base. With a lower regulation schedule and the A-2 reservoir, low discharge exceedance performance improves while high flow discharge exceedance performance worsens when compared to the Future Conditions Base. With the WSE schedule and the A-2 reservoir, high flow discharge exceedance performance improves while low flow discharge exceedance performance worsens when compared to the Future Conditions Base.

The model simulations suggest that the capacity of the C-43 reservoir is sufficient to meet a significant portion of the estuary demand, but the storage is insufficient to address high flow impacts. This points to the need to address high flow impacts with modifications to the Lake Okeechobee Regulation Schedule. The A-2 Reservoir increases regional storage which significantly increases the ability to send more water south to meet a greater Everglades water demand. However, this does not significantly increase the capability to mitigate high flows to the Caloosahatchee Estuary.

## 6.3 St. Lucie Estuary Performance

For the Base Condition Runs (Runs 0-3), the addition of the Caloosahatchee (C-43) and St. Lucie (C-44) storage reservoirs in the Future Conditions Base improves the low flow discharge exceedance performance in the St. Lucie Estuary while not changing high flow discharge exceedance performance.

Reverting to the WSE schedule under existing conditions improves both the low flow discharge exceedance performance and high flow discharge exceedance performance while reverting to WSE under future conditions significantly improves low flow discharge exceedance performance while not changing high flow discharge exceedance performance when compared to the Future Conditions Base.

For the Lake Okeechobee Regulation Schedule Change Runs (Runs 4-12), raising of the LORS 2008 schedule tends to improve low flow discharge exceedance performance in the St. Lucie Estuary while worsening high flow discharge exceedance performance when compared to the Future Conditions Base. Lowering of the LORS 2008 schedule greatly worsens both high flow and low flow discharge exceedance performance. Raising of the WSE schedule tends to improve both high flow and low flow discharge exceedance performance. Lowering of the WSE schedule tends to improve low flow exceedance performance and worsen high flow exceedance performance when compared to the Future Conditions Base. The LORS 2008 schedule deviation slightly improves high discharge exceedance while greatly worsening low flow discharge exceedance performance when compared to the Future Conditions Base.

For the A-2 Reservoir Runs (Runs 13-15), the addition of the A-2 reservoir slightly improved high flow discharge exceedance performance in the St. Lucie Estuary while slightly worsening low flow discharge exceedance performance when compared to the Future Conditions Base. With a lower regulation schedule and the A-2 reservoir, both high flow and low flow discharge exceedance worsen when compared to the Future Conditions Base. With the WSE schedule and the A-2 reservoir, both high flow and low flow discharge exceedance performance improves when compared to the Future Conditions Base.

The model simulations suggest that the capacity of the C-44 Reservoir is sufficient to meet a significant portion of the estuary demand, but the storage is insufficient to address high flow impacts. This points to the need to address high flow impacts with modifications to the Lake Okeechobee Regulation Schedule.

The A-2 Reservoir increases regional storage which significantly increases the ability to send more water south to meet a greater Everglades water demand. However, this does not increase the capability to mitigate high flows to the St. Lucie Estuary.

## 6.4 Everglades Water Deliveries Performance

An important element of any evaluation of the options is the definition of the water needs of the southern Everglades ecosystem. In the RESOPS model there are a range of water flow regimes that could be used to define the Everglades “demand” under any given alternative scenario. The Future Conditions assumes that with the implementation of CEPP, the removal of some of the conveyance restrictions through decompartmentalization of a portion of the WCAs increase the Everglades Demand Time Series commensurate with the removal or modification of several key hydrologic impediments. It’s important to recognize that the selection of the Everglades Demand Time Series can influence the overall hydrologic system performance.

The A-2 reservoir provided an effective means to send Lake Okeechobee regulatory discharge south to meet an increased portion Everglades demands. This performance, however, is predicated upon conveyance improvements downstream in the Water Conservation Areas.

## 6.5 LOSA Water Supply Performance

For the Base Conditions Runs (Runs 0-3), the addition of the Caloosahatchee (C-43) and St. Lucie (C-44) storage reservoirs in the Future Conditions Base improves LOSA water supply performance. Reverting to the WSE schedule also improves LOSA water supply performance for both existing and future conditions.

For the Lake Okeechobee Regulation Schedule Change Runs (Runs 4-12), raising of the LORS 2008 schedule tends to have a negligible effect on LOSA water supply performance when compared to the Future Conditions Base. Raising of the WSE schedule tends to improve LOSA water supply performance when compared to the Future Conditions Base. Lowering of the LORS 2008 schedule tends to greatly worsen LOSA water supply performance when compared to the Future Conditions Base. Lowering of the WSE schedule tends to improve water supply performance when compared to the Future Conditions Base. The LORS 2008 schedule deviation greatly worsens LOSA water supply performance when compared to the Future Conditions Base.

For the A-2 Reservoir Runs (Runs 13-15), the addition of the A-2 reservoir does not change LOSA water supply performance when compared to the Future Conditions Base. With a lower regulation schedule and the A-2 reservoir, LOSA water supply performance worsens when compared to the Future Conditions Base. Reverting to the WSE schedule with the A-2 reservoir improves LOSA water supply performance when compared to the Future Conditions Base.

This performance is generally consistent with past operational changes associated with Lake Okeechobee. When LORS 08 replaced WSE, there was a noted deterioration in overall water supply performance. Therefore, moving the schedule back towards WSE will result in general improvements to water supply capability.

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# APPENDIX A

## Modeling Output

# APPENDIX A

## APPENDIX A: MODELING OUTPUT

Performance summary output sheets for all the RESOPS model runs conducted for this project are included in this appendix.

# Runs 0-3

| SUMMARY OF SIMULATED PERFORMANCE | | | | |
|---|---|---|---|---|
| **PERFORMANCE MEASURE** | **Test 0** | **Test 1** | **Test 2** | **Test 3** |
| | | | | |
| Lake Okeechobee Water Elevation | | | | |
| High LOK Stages (% time>17') | 0.6% | 4.9% | 0.8% | 4.7% |
| Low LOK Stages (% time<10') | 5.5% | 4.1% | 4.3% | 2.4% |
| % time Inside Stage Envelope | 25.0% | 23.0% | 27.4% | 24.4% |
| Std Score Above Stage Envelope | 79 | 55 | 78 | 52 |
| Std Score Below Stage Envelope | 24 | 47 | 35 | 63 |
| Lake O Service Area Water Supply | | | | |
| Mean Annual Cutback Volume (kaf/yr) | 45 | 38 | 33 | 25 |
| Mean Annual Cutback (% of Demand) | 8.3% | 7.0% | 6.6% | 5.1% |
| Mean of 7-Droughts Cutback Volume (kaf/yr) | 153 | 126 | 125 | 95 |
| Mean of 7-Droughts Cutback (% of Demand) | 22.7% | 18.7% | 19.6% | 14.8% |
| Reservoir Utility | | | | |
| North Reservoir Mean Diversion Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| North Reservoir Mean Release Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| West Reservoir Mean Diversion Vol (kaf/yr) | 0 | 0 | 99 | 134 |
| West Reservoir Mean Release Vol (kaf/yr) | 0 | 0 | 85 | 125 |
| East Reservoir Mean Diversion Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| East Reservoir Mean Release Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| South Reservoir Mean InflowVol (kaf/yr) | 73 | 74 | 74 | 74 |
| South Reservoir Mean Release Vol (kaf/yr) | 64 | 64 | 65 | 64 |
| Treatment Area Mean Inflow Vol (kaf/yr) | 334 | 337 | 308 | 312 |
| Treatment Area Mean Release Vol (kaf/yr) | 294 | 297 | 261 | 265 |
| Estuaries | | | | |
| Caloos. Est. High Flow (Months S79>2800cfs) | 82 | 85 | 73 | 75 |
| High Flow Months from C43 Basin Runoff | 42 | 40 | 32 | 29 |
| Additional High Flow Months from LOK Reg | 40 | 45 | 41 | 46 |
| Caloos. Est. Low Flow (Months S79<450cfs) | 53 | 41 | 19 | 22 |
| St. Lucie Est. High Flow (Months SLE>2000cfs) | 89 | 84 | 88 | 88 |
| High Flow Months from Basin Runoff | 49 | 47 | 47 | 47 |
| Additional High Flow Months from LOK Reg | 40 | 37 | 41 | 41 |
| St. Lucie Est. Low Flow (Months SLE<350cfs) | 42 | 34 | 34 | 20 |
| Everglades | | | | |
| Glades Delivery Toward ENV Target (kaf/yr) | 131 | 131 | 131 | 131 |
| Glades Delivery in Excess of ENV target (kaf/yr) | 1083 | 1086 | 1050 | 1054 |
| ENV target not met by Glades Delivery (kaf/yr) | 0 | 0 | 0 | 0 |
| Average Dry Years Glades Delivery (kaf/yr) | 703 | 705 | 676 | 677 |
| Average Dry Season Glades Delivery (kaf/yr) | 365 | 366 | 356 | 357 |
| Glades Target Used | DMSTA(A1FEB) | DMSTA(A1FEB) | DMSTA(A1FEB) | DMSTA(A1FEB) |

Test0 = Run 0 - Existing Conditions Base
Test1 = Run 1 - Existing Conditions with WSE Base
Test2 = Run 2 - Future Conditions Base
Test3 = Run 3 - Future Conditions with WSE Base

# Runs 4-7

| SUMMARY OF SIMULATED PERFORMANCE | | | | |
|---|---|---|---|---|
| **PERFORMANCE MEASURE** | **Test 0** | **Test 1** | **Test 2** | **Test 3** |
| | | | | |
| Lake Okeechobee Water Elevation | | | | |
| High LOK Stages (% time>17') | 2.2% | 4.3% | 8.5% | 14.0% |
| Low LOK Stages (% time<10') | 5.1% | 4.3% | 0.8% | 1.0% |
| % time Inside Stage Envelope | 27.4% | 25.8% | 22.8% | 19.7% |
| Std Score Above Stage Envelope | 79 | 69 | 34 | 16 |
| Std Score Below Stage Envelope | 28 | 42 | 71 | 75 |
| Lake O Service Area Water Supply | | | | |
| Mean Annual Cutback Volume (kaf/yr) | 35 | 33 | 22 | 21 |
| Mean Annual Cutback (% of Demand) | 7.0% | 6.5% | 4.5% | 4.2% |
| Mean of 7-Droughts Cutback Volume (kaf/yr) | 137 | 133 | 77 | 70 |
| Mean of 7-Droughts Cutback (% of Demand) | 21.4% | 20.7% | 12.0% | 11.0% |
| Reservoir Utility | | | | |
| North Reservoir Mean Diversion Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| North Reservoir Mean Release Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| West Reservoir Mean Diversion Vol (kaf/yr) | 93 | 98 | 135 | 136 |
| West Reservoir Mean Release Vol (kaf/yr) | 79 | 85 | 126 | 127 |
| East Reservoir Mean Diversion Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| East Reservoir Mean Release Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| South Reservoir Mean InflowVol (kaf/yr) | 74 | 74 | 74 | 74 |
| South Reservoir Mean Release Vol (kaf/yr) | 65 | 65 | 64 | 64 |
| Treatment Area Mean Inflow Vol (kaf/yr) | 307 | 309 | 314 | 314 |
| Treatment Area Mean Release Vol (kaf/yr) | 260 | 262 | 266 | 267 |
| Estuaries | | | | |
| Caloos. Est. High Flow (Months S79>2800cfs) | 90 | 87 | 69 | 66 |
| High Flow Months from C43 Basin Runoff | 34 | 34 | 27 | 26 |
| Additional High Flow Months from LOK Reg | 56 | 53 | 42 | 40 |
| Caloos. Est. Low Flow (Months S79<450cfs) | 25 | 23 | 19 | 19 |
| St. Lucie Est. High Flow (Months SLE>2000cfs) | 90 | 90 | 84 | 82 |
| High Flow Months from Basin Runoff | 43 | 41 | 46 | 48 |
| Additional High Flow Months from LOK Reg | 47 | 49 | 38 | 34 |
| St. Lucie Est. Low Flow (Months SLE<350cfs) | 41 | 32 | 17 | 17 |
| Everglades | | | | |
| Glades Delivery Toward ENV Target (kaf/yr) | 131 | 131 | 131 | 131 |
| Glades Delivery in Excess of ENV target (kaf/yr) | 1049 | 1051 | 1056 | 1056 |
| ENV target not met by Glades Delivery (kaf/yr) | 0 | 0 | 0 | 0 |
| Average Dry Years Glades Delivery (kaf/yr) | 675 | 675 | 677 | 678 |
| Average Dry Season Glades Delivery (kaf/yr) | 356 | 357 | 358 | 358 |
| Glades Target Used | DMSTA(A1FEB) | DMSTA(A1FEB) | DMSTA(A1FEB) | DMSTA(A1FEB) |

Test0 = Run 4 - Raise LORS 2008 Schedule by 0.5 Feet
Test1 = Run 5 - Raise LORS 2008 Schedule by 1.0 Feet
Test2 = Run 6 - Raise WSE Schedule by 0.5 Feet
Test3 = Run 7 - Raise WSE Schedule by 1.0 Feet

# Runs 8-11

| SUMMARY OF SIMULATED PERFORMANCE | | | | |
|---|---|---|---|---|
| **PERFORMANCE MEASURE** | **Test 0** | **Test 1** | **Test 2** | **Test 3** |
| | | | | |
| Lake Okeechobee Water Elevation | | | | |
| High LOK Stages (% time>17') | 0.2% | 0.0% | 2.8% | 1.2% |
| Low LOK Stages (% time<10') | 11.0% | 14.0% | 3.5% | 4.1% |
| % time Inside Stage Envelope | 24.8% | 19.9% | 26.0% | 29.3% |
| Std Score Above Stage Envelope | 92 | 96 | 67 | 79 |
| Std Score Below Stage Envelope | 0 | 0 | 52 | 43 |
| Lake O Service Area Water Supply | | | | |
| Mean Annual Cutback Volume (kaf/yr) | 49 | 59 | 28 | 31 |
| Mean Annual Cutback (% of Demand) | 9.8% | 11.9% | 5.7% | 6.2% |
| Mean of 7-Droughts Cutback Volume (kaf/yr) | 178 | 196 | 109 | 122 |
| Mean of 7-Droughts Cutback (% of Demand) | 27.8% | 30.5% | 17.1% | 19.0% |
| Reservoir Utility | | | | |
| North Reservoir Mean Diversion Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| North Reservoir Mean Release Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| West Reservoir Mean Diversion Vol (kaf/yr) | 84 | 79 | 133 | 132 |
| West Reservoir Mean Release Vol (kaf/yr) | 69 | 64 | 123 | 121 |
| East Reservoir Mean Diversion Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| East Reservoir Mean Release Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| South Reservoir Mean InflowVol (kaf/yr) | 71 | 61 | 74 | 74 |
| South Reservoir Mean Release Vol (kaf/yr) | 63 | 56 | 65 | 65 |
| Treatment Area Mean Inflow Vol (kaf/yr) | 294 | 277 | 311 | 309 |
| Treatment Area Mean Release Vol (kaf/yr) | 247 | 229 | 263 | 261 |
| Estuaries | | | | |
| Caloos. Est. High Flow (Months S79>2800cfs) | 96 | 106 | 79 | 80 |
| High Flow Months from C43 Basin Runoff | 35 | 35 | 29 | 28 |
| Additional High Flow Months from LOK Reg | 61 | 71 | 50 | 52 |
| Caloos. Est. Low Flow (Months S79<450cfs) | 15 | 15 | 27 | 31 |
| St. Lucie Est. High Flow (Months SLE>2000cfs) | 101 | 111 | 93 | 94 |
| High Flow Months from Basin Runoff | 46 | 49 | 47 | 46 |
| Additional High Flow Months from LOK Reg | 55 | 62 | 46 | 48 |
| St. Lucie Est. Low Flow (Months SLE<350cfs) | 52 | 63 | 26 | 33 |
| Everglades | | | | |
| Glades Delivery Toward ENV Target (kaf/yr) | 131 | 126 | 131 | 131 |
| Glades Delivery in Excess of ENV target (kaf/yr) | 1036 | 1023 | 1052 | 1050 |
| ENV target not met by Glades Delivery (kaf/yr) | 0 | 5 | 0 | 0 |
| Average Dry Years Glades Delivery (kaf/yr) | 668 | 659 | 677 | 676 |
| Average Dry Season Glades Delivery (kaf/yr) | 356 | 350 | 357 | 357 |
| Glades Target Used | DMSTA(A1FEB) | DMSTA(A1FEB) | DMSTA(A1FEB) | DMSTA(A1FEB) |

Test0 = Run 8 - Lower LORS 2008 Schedule by 0.5 Feet
Test1 = Run 9 - Lower LORS 2008 Schedule by 1.0 Feet
Test2 = Run 10 - Lower WSE Regulation Schedule by 0.5 feet
Test3 = Run 11 - Lower WSE Regulation Schedule by 1.0 feet

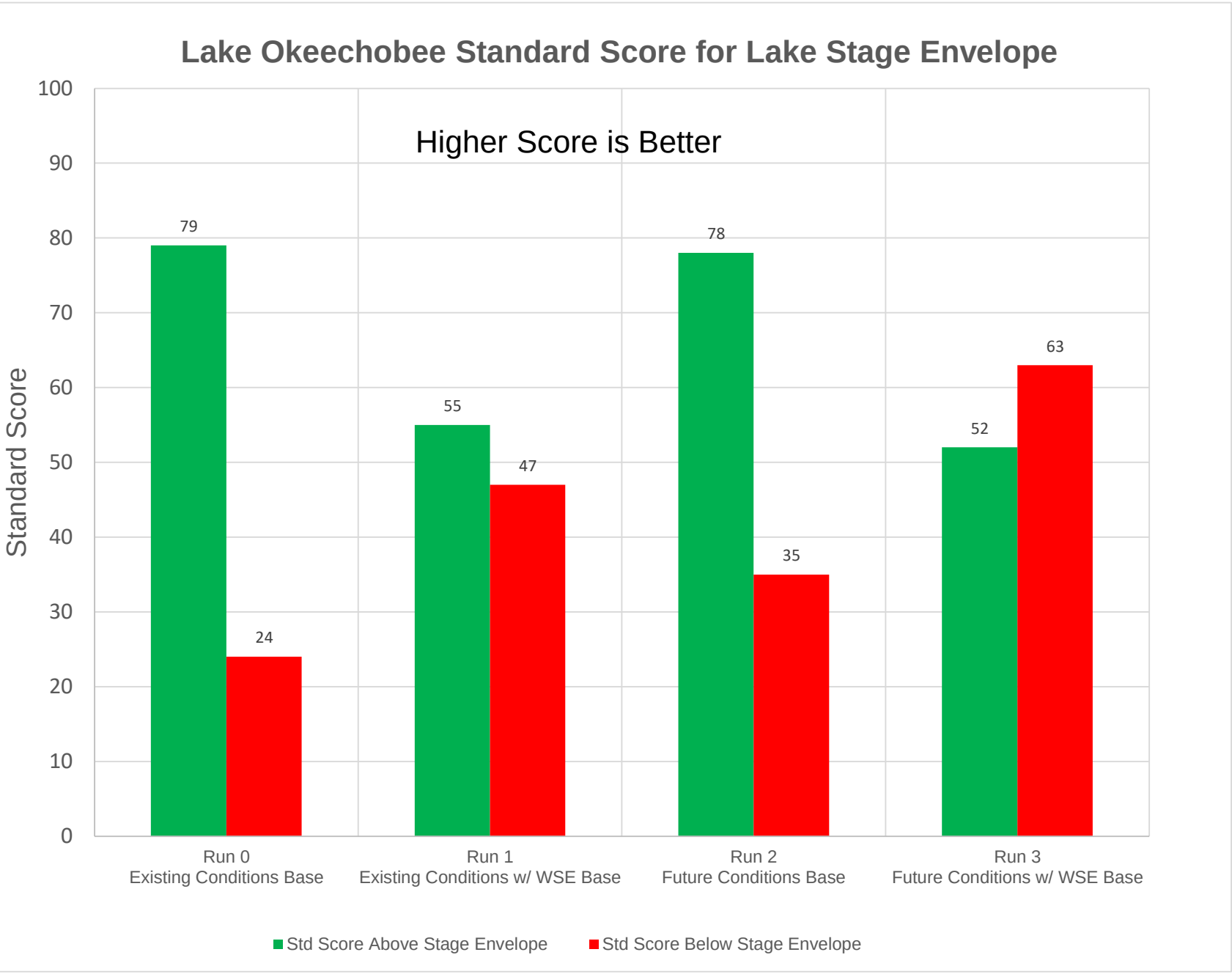
# Runs 12-15

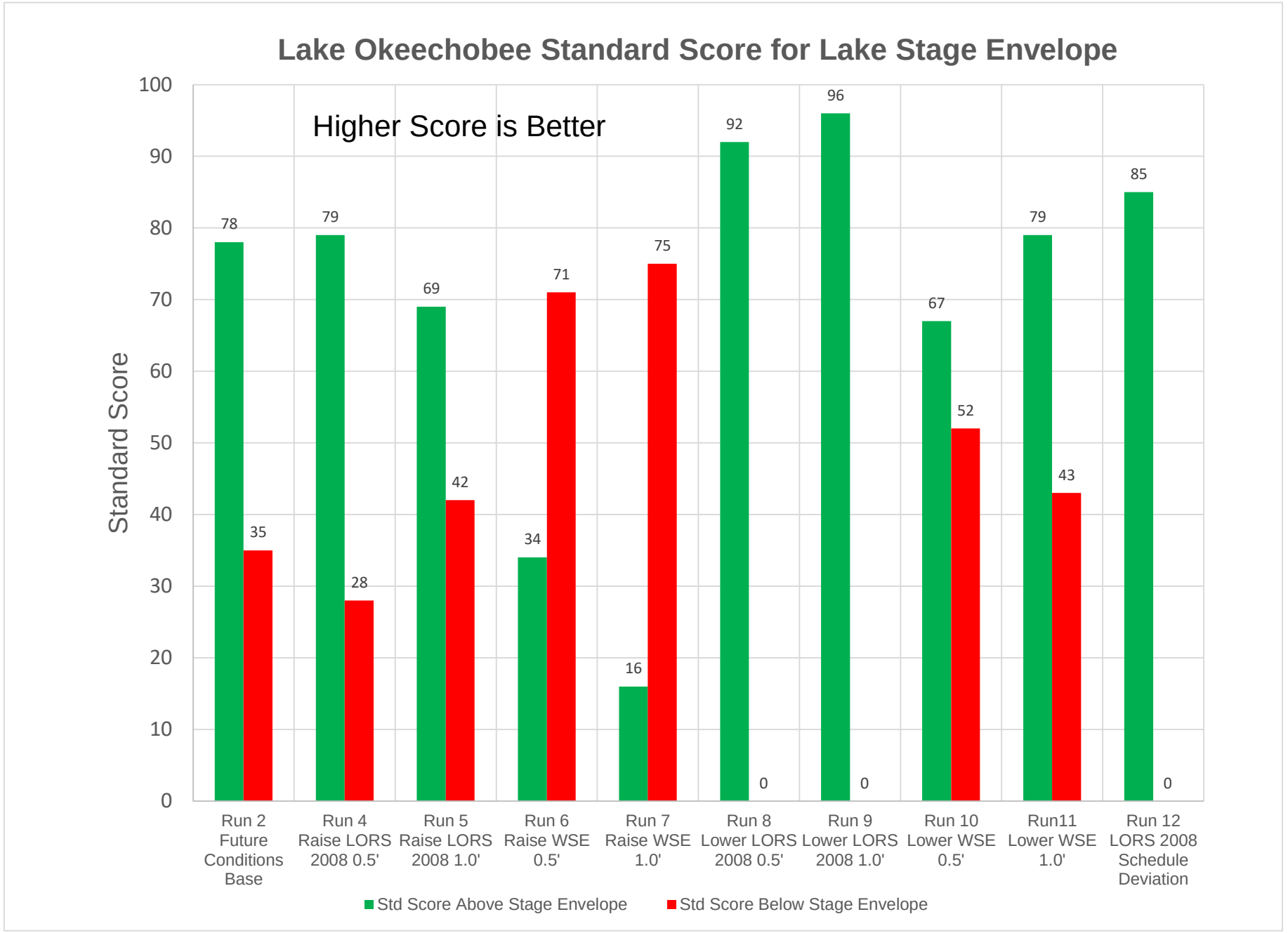
| SUMMARY OF SIMULATED PERFORMANCE | | | | |
|---|---|---|---|---|
| **PERFORMANCE MEASURE** | **Test 0** | **Test 1** | **Test 2** | **Test 3** |
| | | | | |
| Lake Okeechobee Water Elevation | | | | |
| High LOK Stages (% time>17') | 1.2% | 1.2% | 0.0% | 4.5% |
| Low LOK Stages (% time<10') | 10.6% | 4.1% | 7.5% | 3.3% |
| % time Inside Stage Envelope | 22.0% | 25.2% | 25.4% | 24.2% |
| Std Score Above Stage Envelope | 85 | 79 | 92 | 58 |
| Std Score Below Stage Envelope | 0 | 33 | 1 | 56 |
| Lake O Service Area Water Supply | | | | |
| Mean Annual Cutback Volume (kaf/yr) | 51 | 32 | 41 | 26 |
| Mean Annual Cutback (% of Demand) | 10.3% | 6.6% | 8.5% | 5.4% |
| Mean of 7-Droughts Cutback Volume (kaf/yr) | 167 | 123 | 140 | 100 |
| Mean of 7-Droughts Cutback (% of Demand) | 26.2% | 19.8% | 22.5% | 16.1% |
| Reservoir Utility | | | | |
| North Reservoir Mean Diversion Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| North Reservoir Mean Release Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| West Reservoir Mean Diversion Vol (kaf/yr) | 93 | 100 | 86 | 136 |
| West Reservoir Mean Release Vol (kaf/yr) | 79 | 86 | 71 | 127 |
| East Reservoir Mean Diversion Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| East Reservoir Mean Release Vol (kaf/yr) | 0 | 0 | 0 | 0 |
| South Reservoir Mean InflowVol (kaf/yr) | 69 | 213 | 205 | 220 |
| South Reservoir Mean Release Vol (kaf/yr) | 61 | 195 | 191 | 200 |
| Treatment Area Mean Inflow Vol (kaf/yr) | 294 | 341 | 297 | 366 |
| Treatment Area Mean Release Vol (kaf/yr) | 247 | 293 | 250 | 319 |
| Estuaries | | | | |
| Caloos. Est. High Flow (Months S79>2800cfs) | 67 | 70 | 81 | 67 |
| High Flow Months from C43 Basin Runoff | 34 | 32 | 35 | 29 |
| Additional High Flow Months from LOK Reg | 33 | 38 | 46 | 38 |
| Caloos. Est. Low Flow (Months S79<450cfs) | 27 | 21 | 13 | 27 |
| St. Lucie Est. High Flow (Months SLE>2000cfs) | 80 | 88 | 91 | 85 |
| High Flow Months from Basin Runoff | 42 | 49 | 48 | 48 |
| Additional High Flow Months from LOK Reg | 38 | 39 | 43 | 37 |
| St. Lucie Est. Low Flow (Months SLE<350cfs) | 64 | 37 | 55 | 25 |
| Everglades | | | | |
| Glades Delivery Toward ENV Target (kaf/yr) | 130 | 489 | 488 | 490 |
| Glades Delivery in Excess of ENV target (kaf/yr) | 1038 | 724 | 683 | 749 |
| ENV target not met by Glades Delivery (kaf/yr) | 1 | 2 | 3 | 1 |
| Average Dry Years Glades Delivery (kaf/yr) | 656 | 767 | 759 | 780 |
| Average Dry Season Glades Delivery (kaf/yr) | 354 | 457 | 453 | 462 |
| Glades Target Used | DMSTA(A1FEB) | HYB:CEPP(100k)+DMSTA(A1FEB) | HYB:CEPP(100k)+DMSTA(A1FEB) | HYB:CEPP(100k)+DMSTA(A1FEB) |

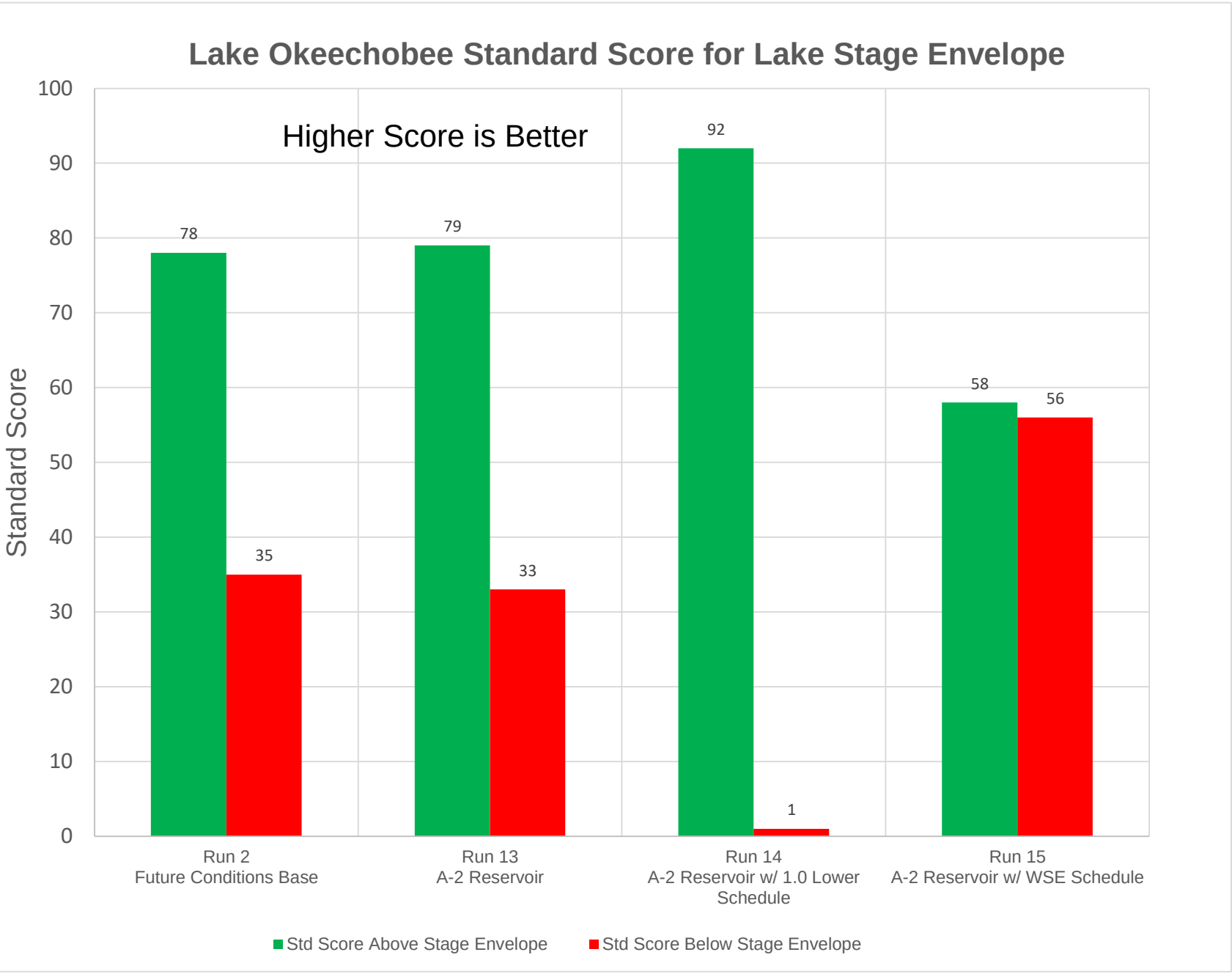
Test0 = Run 12 - LORS 2008 Schedule Deviation
Test1 = Run 13 - A-2 Reservoir
Test2 = Run 14 - A-2 Reservoir with 1.0-foot Lower Regulation Schedule
Test3 = Run 15 - A-2 Reservoir with WSE Regulation Schedule

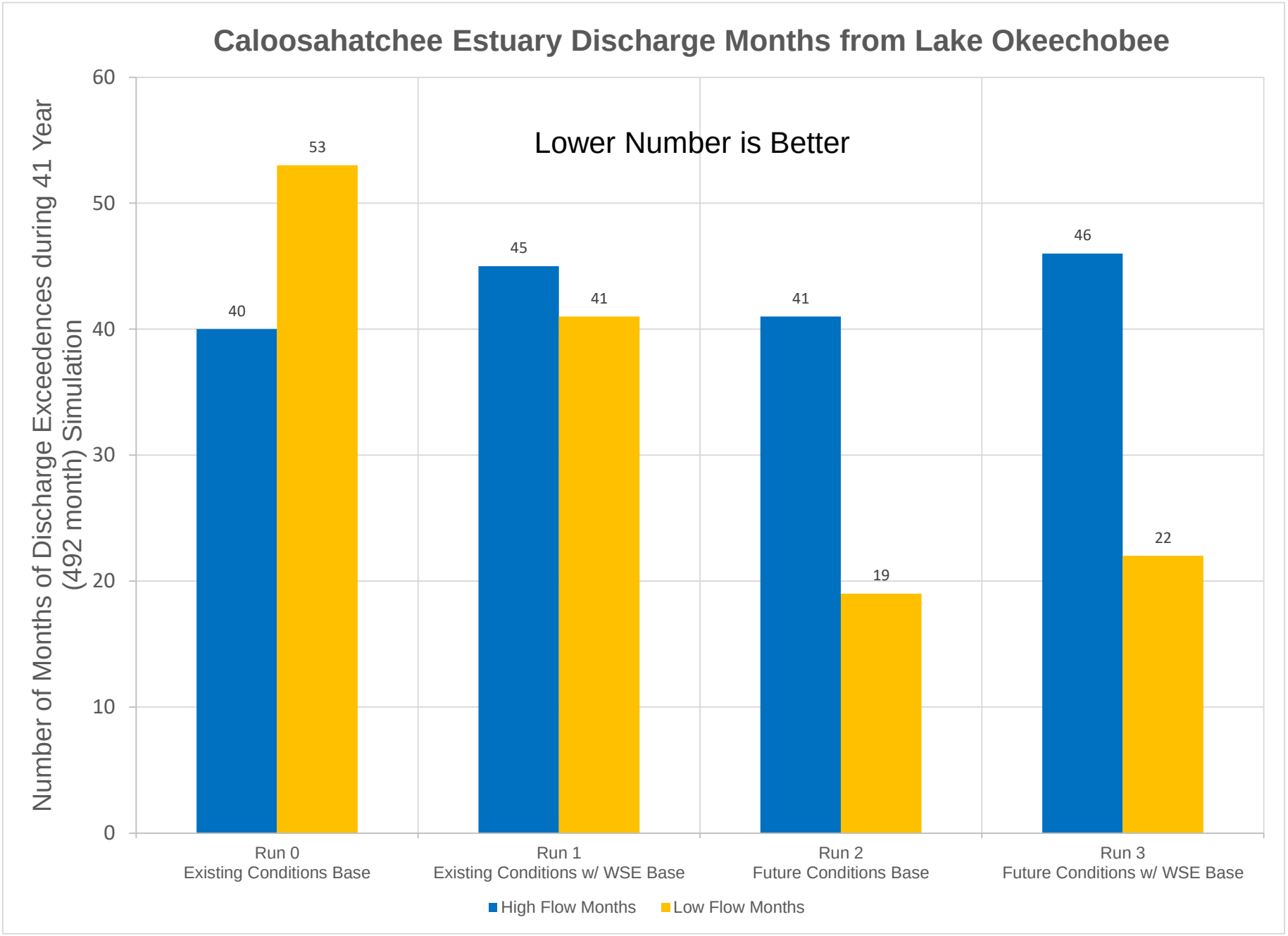
# APPENDIX B

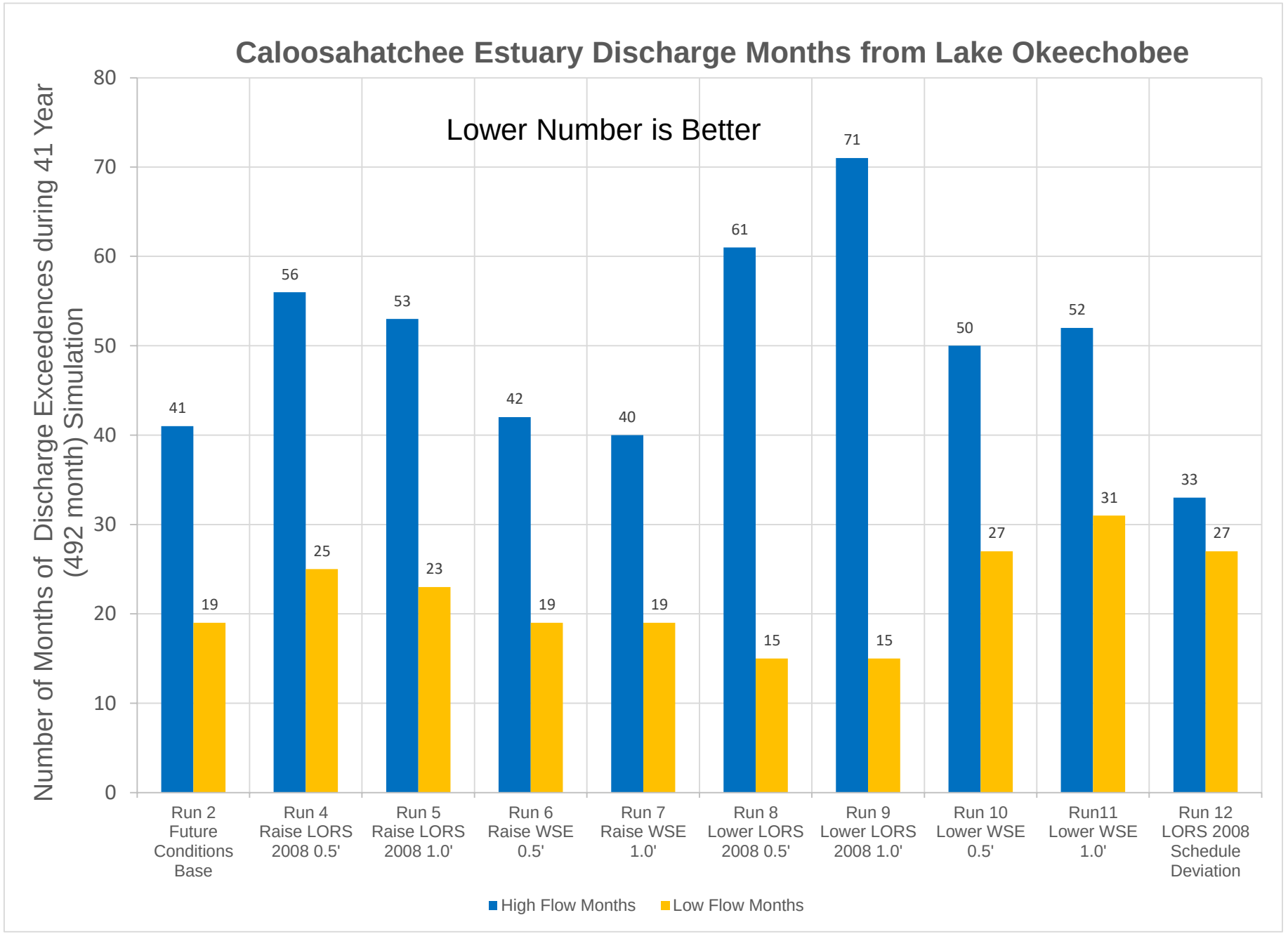
## Performance Graphs

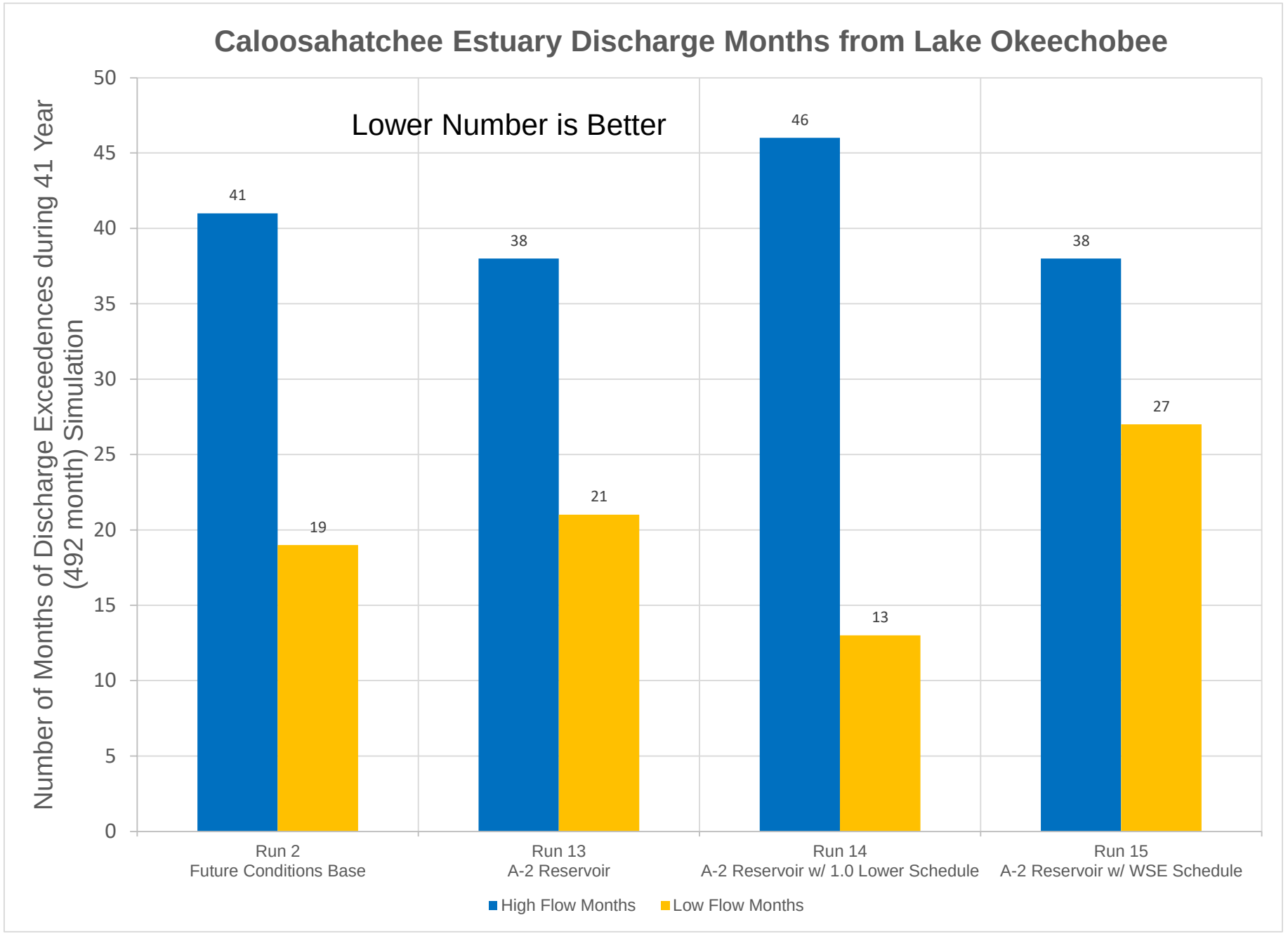

Lake Okeechobee Standard Score for Lake Stage Envelope
Higher Score is Better
Standard Score
100
90
80
70
60
50
40
30
20
10
0
79
24
55
47
78
35
52
63
Run 0
Existing Conditions Base
Run 1
Existing Conditions w/ WSE Base
Run 2
Future Conditions Base
Run 3
Future Conditions w/ WSE Base
Std Score Above Stage Envelope
Std Score Below Stage Envelope

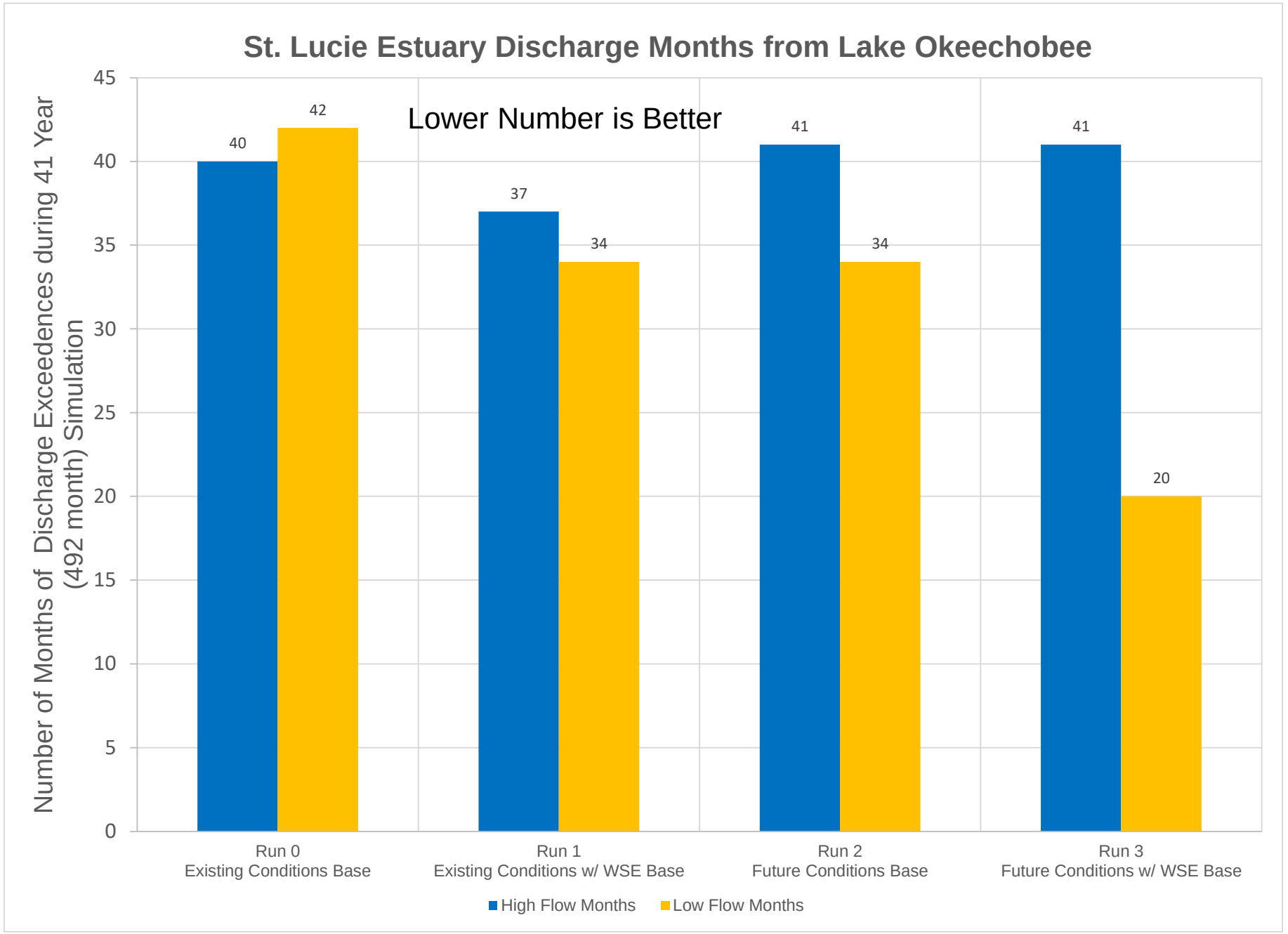

Lake Okeechobee Standard Score for Lake Stage Envelope
Higher Score is Better
Standard Score
100
90
80
70
60
50
40
30
20
10
0
78
35
79
28
69
42
34
71
16
75
92
0
96
0
67
52
79
43
85
0
Run 2 Future Conditions Base
Run 4 Raise LORS 2008 0.5'
Run 5 Raise LORS 2008 1.0'
Run 6 Raise WSE 0.5'
Run 7 Raise WSE 1.0'
Run 8 Lower LORS 2008 0.5'
Run 9 Lower LORS 2008 1.0'
Run 10 Lower WSE 0.5'
Run11 Lower WSE 1.0'
Run 12 LORS 2008 Schedule Deviation
Std Score Above Stage Envelope
Std Score Below Stage Envelope

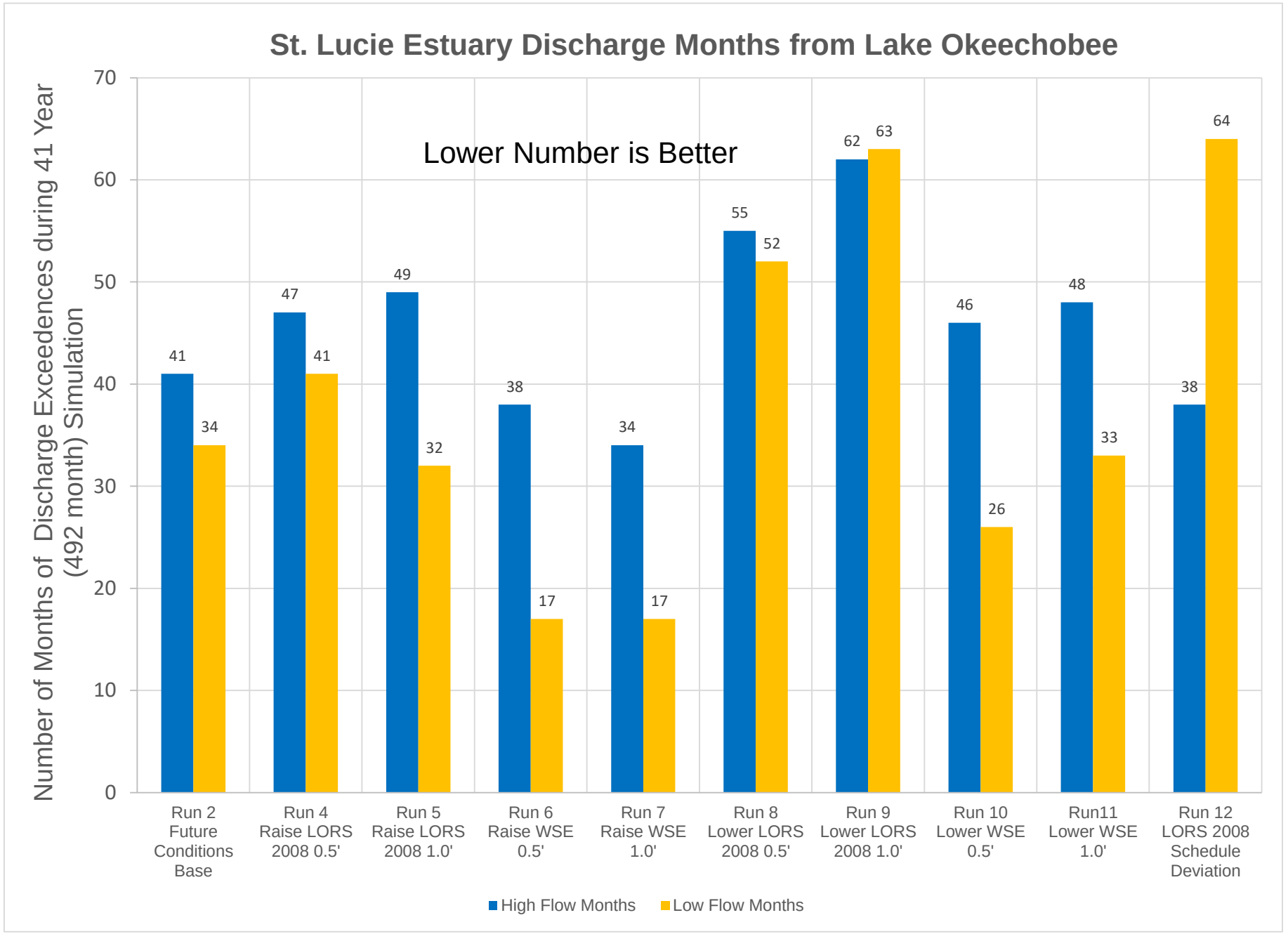

Lake Okeechobee Standard Score for Lake Stage Envelope
Higher Score is Better
Standard Score
100
90
80
70
60
50
40
30
20
10
0
78
35
79
33
92
1
58
56
Run 2
Future Conditions Base
Run 13
A-2 Reservoir
Run 14
A-2 Reservoir w/ 1.0 Lower Schedule
Run 15
A-2 Reservoir w/ WSE Schedule
Std Score Above Stage Envelope
Std Score Below Stage Envelope

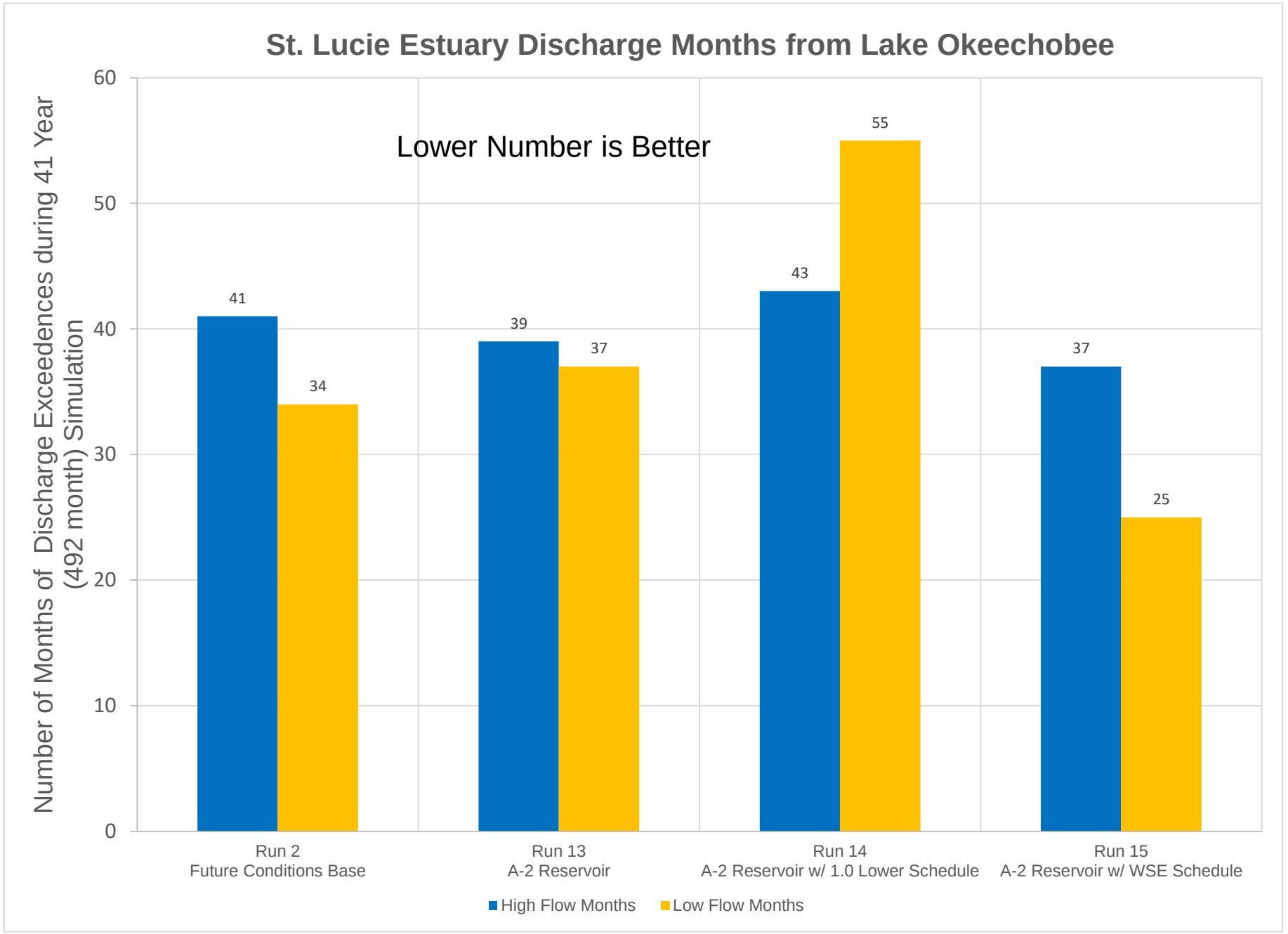

Caloosahatchee Estuary Discharge Months from Lake Okeechobee
Lower Number is Better
Number of Months of Discharge Exceedences during 41 Year (492 month) Simulation
60
50
40
30
20
10
0
40
53
45
41
41
19
46
22
Run 0
Existing Conditions Base
Run 1
Existing Conditions w/ WSE Base
Run 2
Future Conditions Base
Run 3
Future Conditions w/ WSE Base
High Flow Months
Low Flow Months

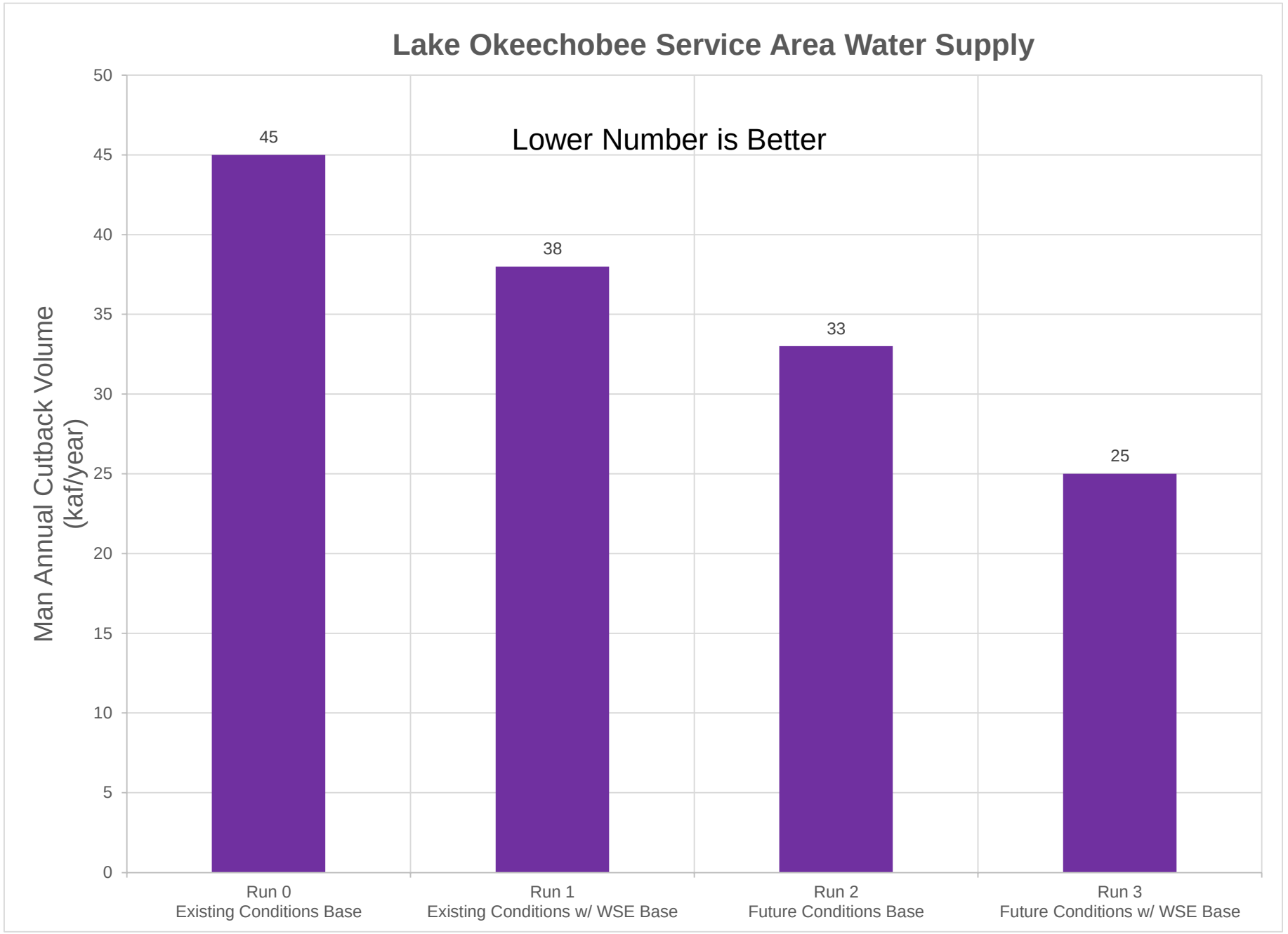

Caloosahatchee Estuary Discharge Months from Lake Okeechobee
Lower Number is Better
Number of Months of Discharge Exceedences during 41 Year (492 month) Simulation
0
10
20
30
40
50
60
70
80
41
19
56
25
53
23
42
19
40
19
61
15
71
15
50
27
52
31
33
27
Run 2 Future Conditions Base
Run 4 Raise LORS 2008 0.5'
Run 5 Raise LORS 2008 1.0'
Run 6 Raise WSE 0.5'
Run 7 Raise WSE 1.0'
Run 8 Lower LORS 2008 0.5'
Run 9 Lower LORS 2008 1.0'
Run 10 Lower WSE 0.5'
Run11 Lower WSE 1.0'
Run 12 LORS 2008 Schedule Deviation
High Flow Months
Low Flow Months

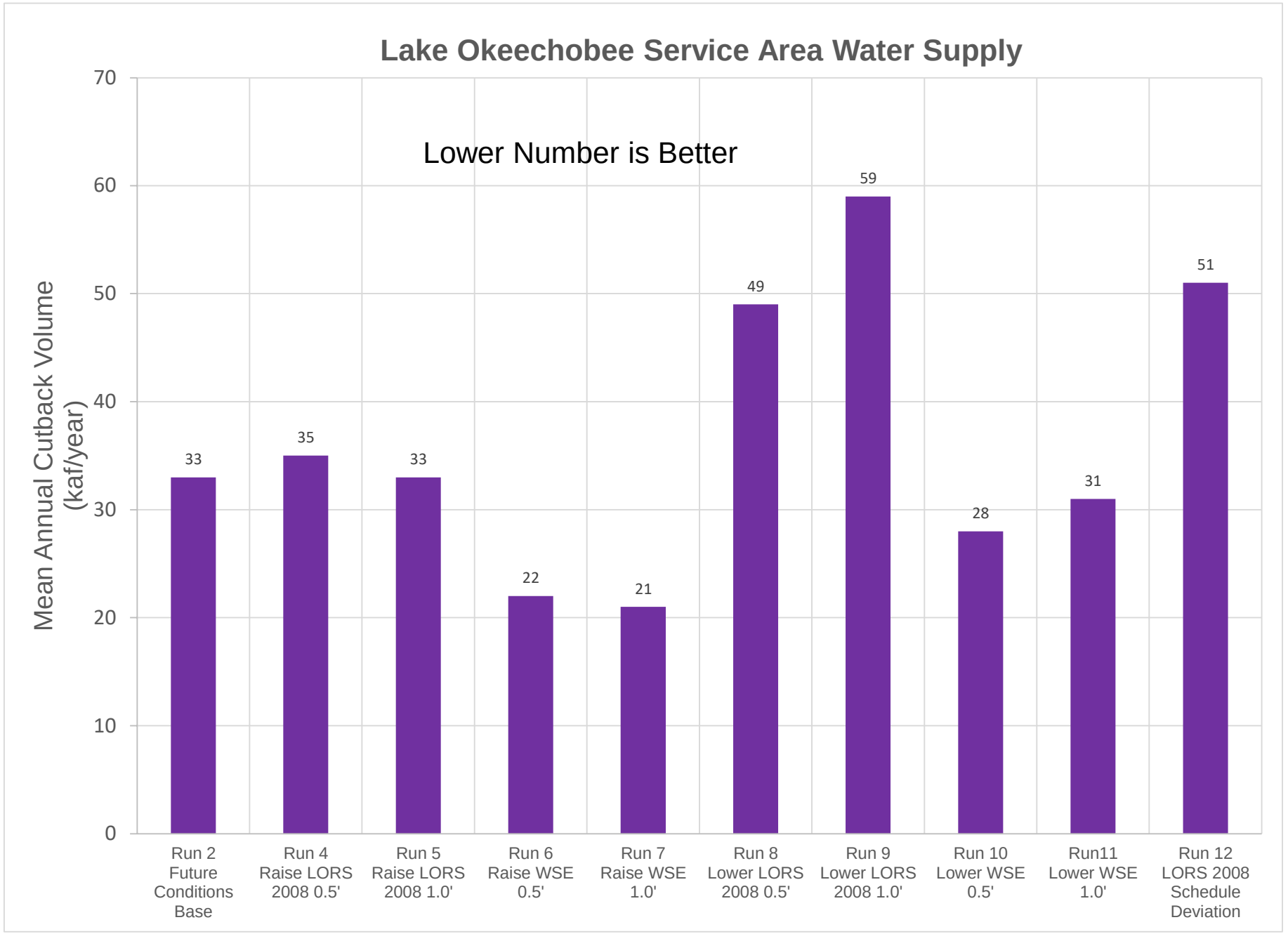

Caloosahatchee Estuary Discharge Months from Lake Okeechobee
Lower Number is Better
Number of Months of Discharge Exceedences during 41 Year (492 month) Simulation
50
45
40
35
30
25
20
15
10
5
0
41
19
38
21
46
13
38
27
Run 2
Future Conditions Base
Run 13
A-2 Reservoir
Run 14
A-2 Reservoir w/ 1.0 Lower Schedule
Run 15
A-2 Reservoir w/ WSE Schedule
High Flow Months
Low Flow Months

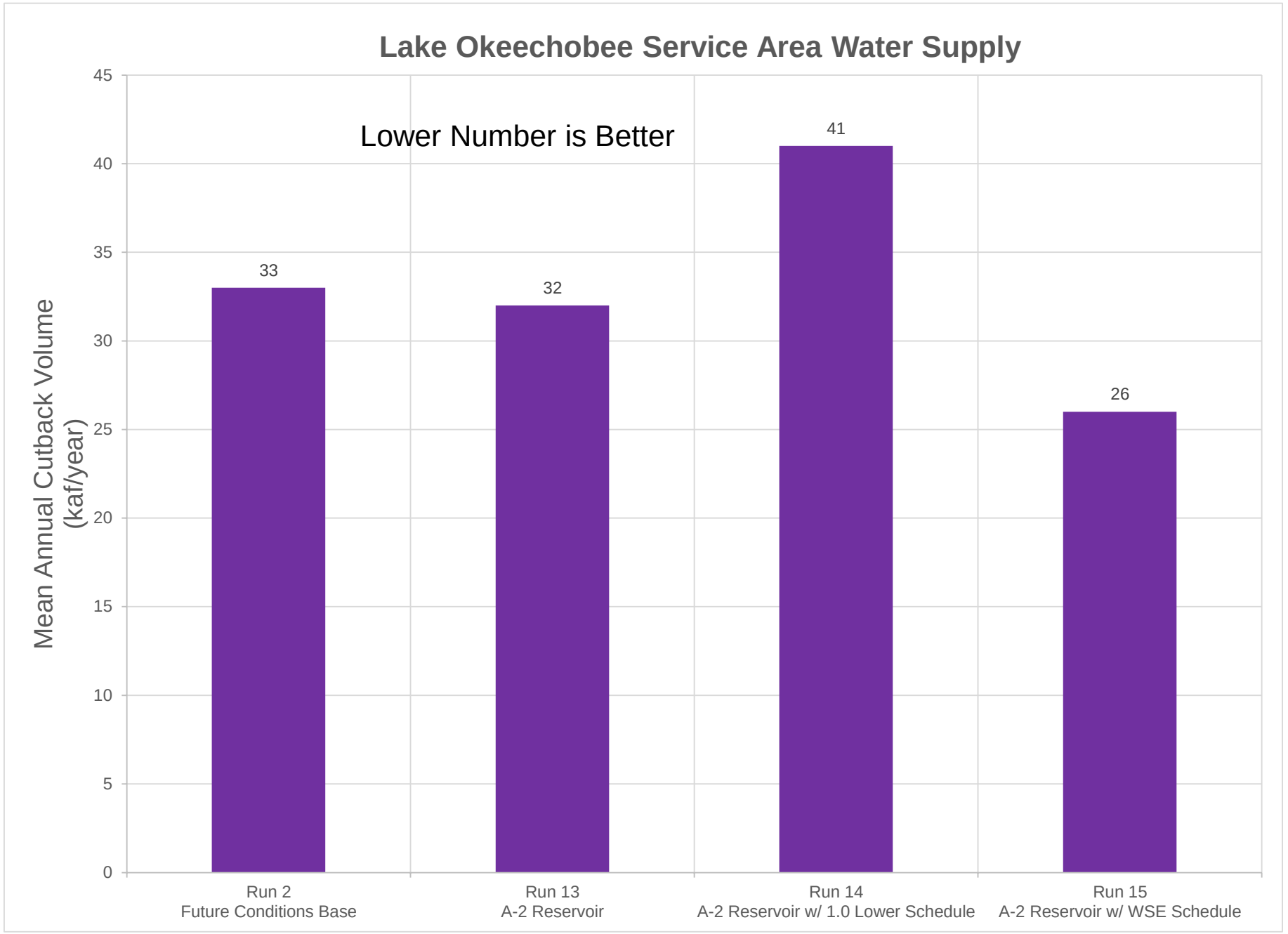

St. Lucie Estuary Discharge Months from Lake Okeechobee
Lower Number is Better
Number of Months of Discharge Exceedences during 41 Year (492 month) Simulation
45
40
35
30
25
20
15
10
5
0
40
42
37
34
41
34
41
20
Run 0
Existing Conditions Base
Run 1
Existing Conditions w/ WSE Base
Run 2
Future Conditions Base
Run 3
Future Conditions w/ WSE Base
High Flow Months
Low Flow Months


St. Lucie Estuary Discharge Months from Lake Okeechobee
Lower Number is Better
Number of Months of Discharge Exceedences during 41 Year (492 month) Simulation
70
60
50
40
30
20
10
0
41
34
47
41
49
32
38
17
34
17
55
52
62
63
46
26
48
33
38
64
Run 2 Future Conditions Base
Run 4 Raise LORS 2008 0.5'
Run 5 Raise LORS 2008 1.0'
Run 6 Raise WSE 0.5'
Run 7 Raise WSE 1.0'
Run 8 Lower LORS 2008 0.5'
Run 9 Lower LORS 2008 1.0'
Run 10 Lower WSE 0.5'
Run11 Lower WSE 1.0'
Run 12 LORS 2008 Schedule Deviation
High Flow Months
Low Flow Months


St. Lucie Estuary Discharge Months from Lake Okeechobee
Lower Number is Better
Number of Months of Discharge Exceedences during 41 Year (492 month) Simulation
60
50
40
30
20
10
0
41
34
39
37
43
55
37
25
Run 2
Future Conditions Base
Run 13
A-2 Reservoir
Run 14
A-2 Reservoir w/ 1.0 Lower Schedule
Run 15
A-2 Reservoir w/ WSE Schedule
High Flow Months
Low Flow Months


Lake Okeechobee Service Area Water Supply
Lower Number is Better
Man Annual Cutback Volume (kaf/year)
50
45
40
35
30
25
20
15
10
5
0
45
38
33
25
Run 0
Existing Conditions Base
Run 1
Existing Conditions w/ WSE Base
Run 2
Future Conditions Base
Run 3
Future Conditions w/ WSE Base


Lake Okeechobee Service Area Water Supply
Lower Number is Better
Mean Annual Cutback Volume (kaf/year)
70
60
50
40
30
20
10
0
33
35
33
22
21
49
59
28
31
51
Run 2 Future Conditions Base
Run 4 Raise LORS 2008 0.5'
Run 5 Raise LORS 2008 1.0'
Run 6 Raise WSE 0.5'
Run 7 Raise WSE 1.0'
Run 8 Lower LORS 2008 0.5'
Run 9 Lower LORS 2008 1.0'
Run 10 Lower WSE 0.5'
Run11 Lower WSE 1.0'
Run 12 LORS 2008 Schedule Deviation


Lake Okeechobee Service Area Water Supply
Lower Number is Better
Mean Annual Cutback Volume (kaf/year)
45
40
35
30
25
20
15
10
5
0
33
32
41
26
Run 2
Future Conditions Base
Run 13
A-2 Reservoir
Run 14
A-2 Reservoir w/ 1.0 Lower Schedule
Run 15
A-2 Reservoir w/ WSE Schedule

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